A CAHNERS PUBLICATION INTERNATIONAL EDITION APRIL 28, 1988

EDN®

ELECTRO/88 PREVIEW: SESSIONS & PRODUCTS

Part 5 of EDN's Decade 90 Series

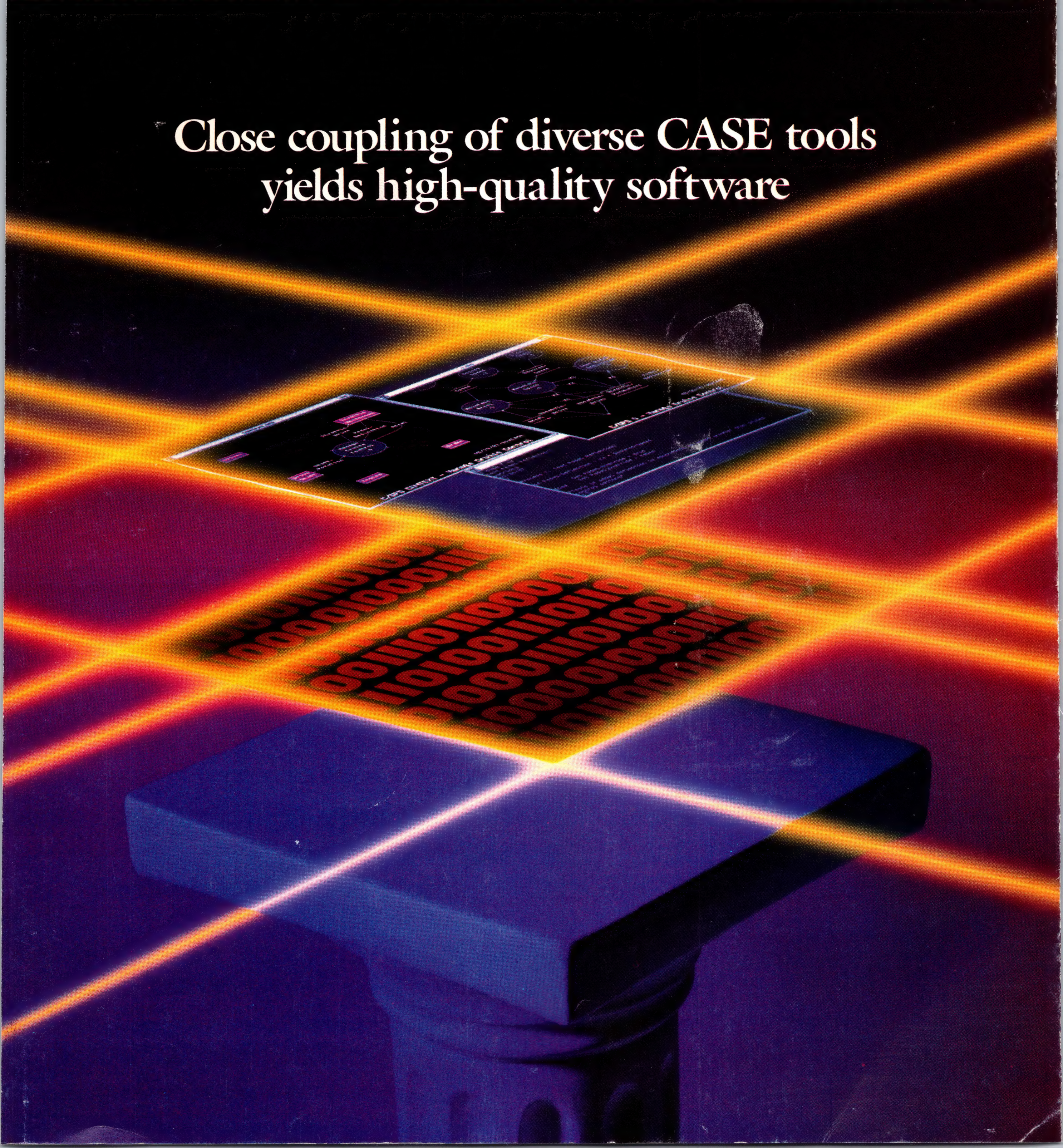
Machine-vision systems perform real-world tasks

Optocoupler update

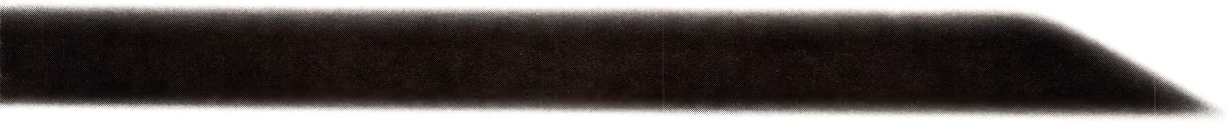
9 MAY 1988

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

Close coupling of diverse CASE tools yields high-quality software



Devices' 29K.
platform.



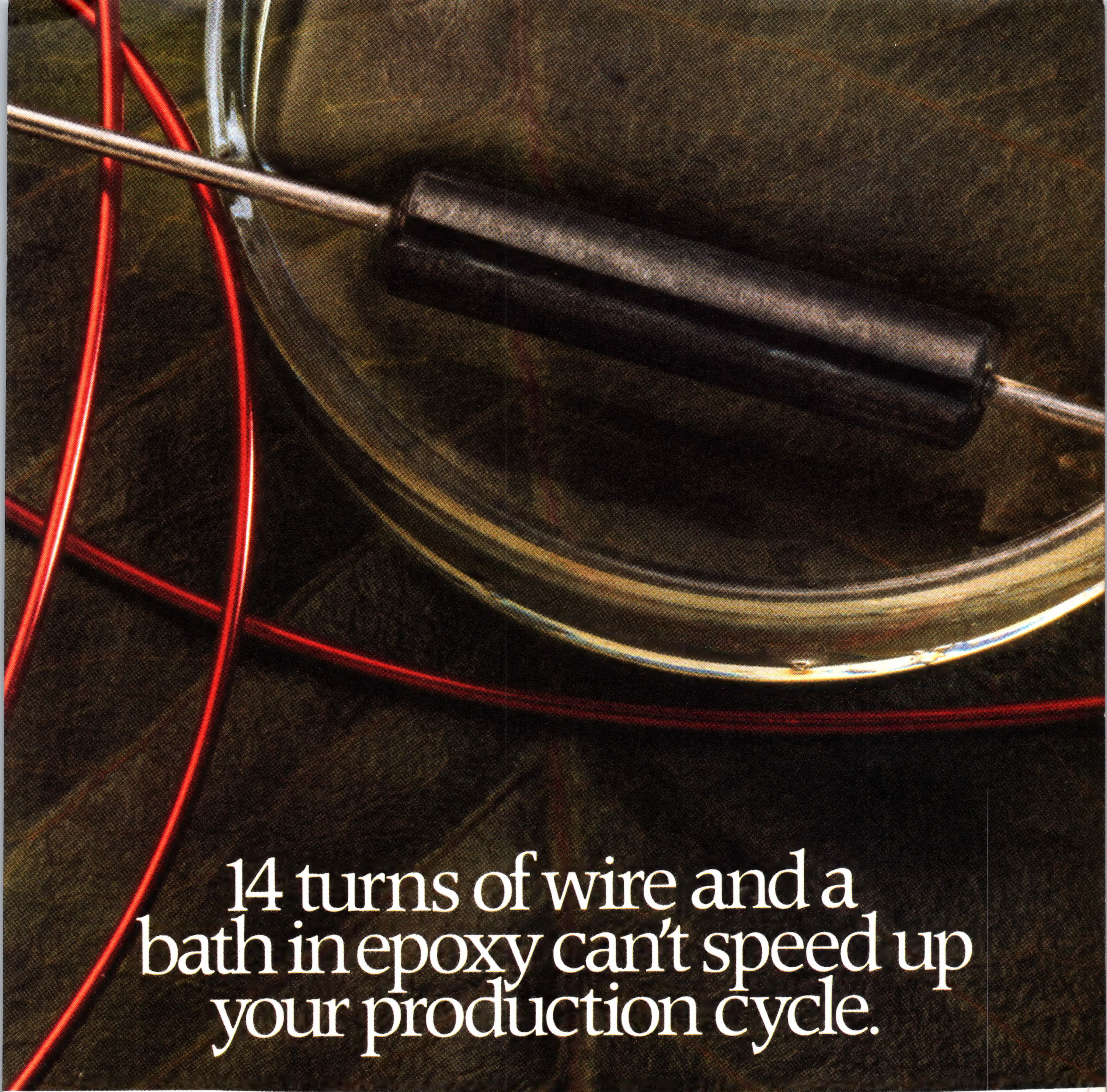
ADVANCED MICRO DEVICES. For more information, write "29K" on your letterhead and mail to:
P.O. Box 4, Westbury-on-Trym, Bristol BS9 3DS, United Kingdom.
Bruxelles (02-2) 771 91 42 • Hannover area (0511) 73 60 85 • Hong Kong (5) 8654525 • London area (04862) 22121
Manchester area (0925) 828008 • Milano (02) 3533241 • München (089) 41 14-0 • Osaka (06) 243-3250 • Paris (1) 49 75 10 10
Seoul (02) 784-7598 • Singapore (65) 225 7544 • Stockholm (08) 733 03 50 • Stuttgart (0711) 62 33 77 • Taiwan (02) 7122066
Tokyo (03) 345-8241 • Latin America, Fort Lauderdale, Florida/U.S.A. Tel: (305) 484-8600 Tlx: (510) 955-4261 amd ftl.
29K logo is a trademark of Advanced Micro Devices. © Advanced Micro Devices, Inc. 1988.

CIRCLE NO 179

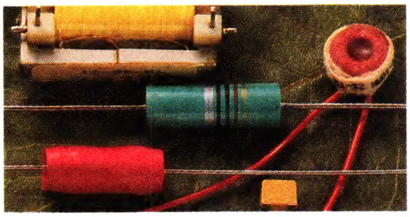
Advanced Micro
The next

Seventeen MIPS with a single 32-bit RISC chip. Sustained. 42,000 dhrystones. In CMOS. Complete hardware and software development support. Optimizing compilers. Assemblers. Debuggers. Industry standard operating systems. Hardware development tools.

Documentation, training and customer support. Now.


14 turns of wire and a bath in epoxy can't speed up your production cycle.

Dale® Can.



The phone book is full of magnetics suppliers. But one call — to Dale® Electronics — can add more than just a supplier to your next project.

We have the breadth of line, the staff and the facilities to deliver the exact part you need, exactly on time. We can document this in many ways — including a customer list full of firms who've proven it's more efficient to turn in-house magnetics production over to us.

So tell us your needs: A molded, shielded inductor, a MIL-C-15305 model, a high-volume, roll-coated choke, a custom switch model design. Off-the-shelf or one of a kind, Dale can be the partner you need to provide time-saving, cost-efficient magnetic components.

Call today or write for a copy of our expanded Magnetic Components Catalog. Dale Electronics, Inc., East Highway 50, Yankton, South Dakota 57078. Phone: 605-665-9301.

DALE®

Dale Makes Your Basics Better

Circle No. 1

British Telecom says,

"Fifty approvals from one lab – Thanks DS&G!"

Gavin Steven
British Telecom/
Mitel Datacom

"At British Telecom we knew that a single compliance problem could have crippled our introduction and damaged our reputation. So we chose the best facility." They chose DS&G.

No Lab Offers More Approvals

DS&G offers every approval you will ever need. They offer a complete line of EMI, telecom, and safety certifications. For EMI, they can get approval by the FCC, the Canadian DOC, the German VDE, and the Japanese VCCI. For telecom, they offer FCC, DOC, BABT (British), and JATE (Japanese) approval. For safety, they can obtain the marks of UL, CSA (Canada), and TUV (Germany).

DS&G Does It All

DS&G works with you all the way from initial design to complete retrofit. They can handle every aspect of your compliance program, including liason with government agencies. But DS&G does even more. It annually publishes the industry's reference book on designing for compliance, "Compliance Engineering." It also consults with U.S. and foreign governments on developing technology and regulations. So you know you are getting the most comprehensive, up-to-date service.

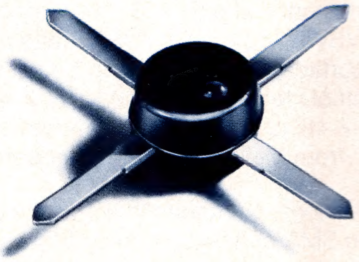
"On Time and On Budget!"

British Telecom was particularly impressed that DS&G got so many approvals without any delays or cost overruns. Your approval program can go as smoothly as their's did. You can choose DS&G. Call now at 617 263-2662.

Dash Straus & Goodhue, Inc.
593 Massachusetts Ave.
Boxborough, MA 01719
(617) 263-2662
After 7/19/88: (508) 263-2662

DSG
Dash Straus & Goodhue

from 99¢



dc to 2000 MHz amplifier series

SPECIFICATIONS

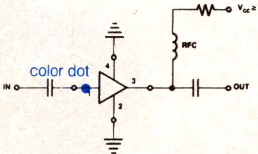
MODEL	FREQ. MHz	GAIN, dB 100 MHz	1000 MHz	2000 MHz	Min. (note)	•MAX. PWR. dBm	NF dB	PRICE $ Ea.	Qty.
MAR-1	DC-1000	18.5	15.5	—	13.0	0	5.0	0.99	(100)
MAR-2	DC-2000	13	12.5	11	8.5	+3	6.5	1.50	(25)
MAR-3	DC-2000	13	12.5	10.5	8.0	+8□	6.0	1.70	(25)
MAR-4	DC-1000	8.2	8.0	—	7.0	+11	7.0	1.90	(25)
MAR-6	DC-2000	20	16	11	9	0	2.8	1.29	(25)
MAR-7	DC-2000	13.5	12.5	10.5	8.5	+3	5.0	1.90	(25)
MAR-8	DC-1000	33	23	—	19	+10	3.5	2.20	(25)

NOTE: Minimum gain at highest frequency point and over full temperature range.
• 1dB Gain Compression
□ +4dBm 1 to 2 GHz

designers amplifier kit, DAK-2

5 of each model, total 35 amplifiers

only $59.95



Unbelievable, until now…tiny monolithic wide-band amplifiers for as low as 99 cents. These rugged 0.085 in.diam.,plastic-packaged units are 50ohm* input/output impedance, unconditionally stable regardless of load*, and easily cascadable. Models in the MAR-series offer up to 33 dB gain, 0 to +11dBm output, noise figure as low as 2.8dB, and up to DC-2000MHz bandwidth.

*MAR-8, Input/Output Impedance is not 50ohms, see data sheet.
Stable for source/load impedance VSWR less than 3:1

Also, for your design convenience, Mini-Circuits offers chip coupling capacitors at 12 cents each.†

Size (mils)	Tolerance	Temperature Characteristic	Value
80 × 50	5%	NPO	10, 22, 47, 68, 100, 470, 680, 100 pf
80 × 50	10%	X7R	2200, 4700, 6800, 10,000 pf
120 × 60	10%	X7R	.022, .047. .068, .1μf

† Minimum Order 50 per Value

finding new ways…
setting higher standards

Mini-Circuits
A Division of Scientific Components Corporation
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500
Fax (718) 332-4661 Domestic and International Telexes: 6852844 or 620156

CIRCLE NO 77

C113-Rev. D

tiny SPDT switches

absorptive... reflective

dc to 4.6GHz from 32^{95} (1-24)

Tough enough to pass stringent MIL-STD-883 tests, useable from dc to 6GHz and smaller than most RF switches, Mini-Circuits' hermetically-sealed (reflective) KSW-2-46 and (absorptive) KSWA-2-46 offer a new, unexplored horizon of applications. Unlike pin diode switches that become ineffective below 1MHz, these GaAs switches can operate down to dc with control voltage as low as -5V, at a blinding 2ns switching speed.

Despite its extremely tiny size, only 0.185 by 0.185 by 0.06 in., these switches provide 50dB isolation (considerably higher than many larger units) and insertion loss of only 1dB. The absorptive model KSWA-2-46 exhibits a typical VSWR of 1.5 in its "OFF" state over the entire frequency range. These surface-mount units can be soldered to pc boards using conventional assembly techniques. The KSW-2-46, priced at only $32.95, and the KSWA-2-46, at $48.95, are the latest examples of components from Mini-Circuits with unbeatable price/performance.

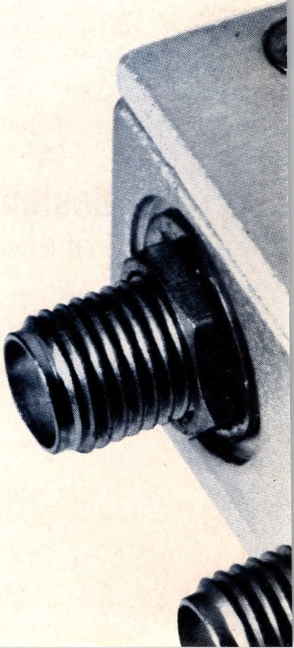
Connector versions, packaged in a 1.25 x 1.25 x 0.75 in. metal case, contain five SMA connectors, including one at each control port to maintain 3ns switching speed.

Switch fast... to Mini-Circuits' GaAs switches.

SPECIFICATIONS

Pin Model	**KSW-2-46**		**KSWA-2-46**	
Connector Version	**ZFSW-2-46**		**ZFSWA-2-46**	
FREQ. RANGE	dc-4.6 GHz		dc-4.6 GHz	
INSERT. LOSS (db)	typ	max	typ	max
dc-200MHz	0.9	1.1	0.8	1.1
200-1000MHz	1.0	1.3	0.9	1.3
1-4.6GHz	1.3	1.7	1.5	2.6
ISOLATION (dB)	typ	min	typ	min
dc-200MHz	60	50	60	50
200-1000MHz	45	40	50	40
1-4.6GHz	30	23	30	25
VSWR (typ) ON	1.3:1		1.3	
OFF	—		1.4	
SW. SPEED (nsec) rise or fall time	2(typ)		3(typ)	
MAX RF INPUT (bBm)				
up to 500MHz	+17		+17	
above 500MHz	+27		+27	
CONTROL VOLT.	**-5V** on, OV off		**-5V** on, OV off	
OPER/STOR TEMP.	-55° to +125°C		-55° to +125°C	
PRICE (1-24)	**$32.95** **$72.95**		**$48.95** **$88.95**	

C 117 REV. D



finding new ways...
setting higher standards

Mini-Circuits

A Division of Scientific Components Corporation
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500
Fax (718) 332-4661 Domestic and International Telexes: 6852844 or 620156

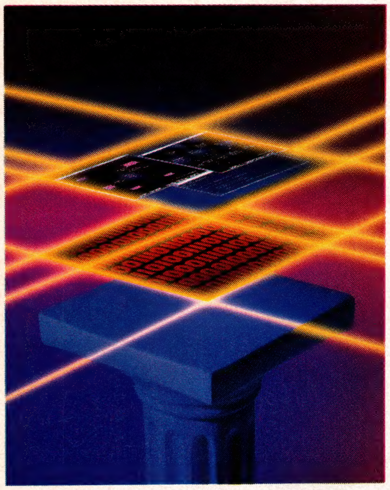
CIRCLE NO 78

Volume 33, Number 9

EDN

April 28, 1988

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS



***On the cover:** CASE tools link all phases of the software design process—from concept to maintenance. See pg 110. (Photo courtesy Tektronix Inc, Computer-Aided Software Engineering Div)*

DESIGN FEATURES

Special Report: CASE tools 110

Computer-aided software engineering is becoming vital to the success of large projects, and vendors are starting to make progress in filling two of the technology's most serious gaps.—*Chris Terry, Associate Editor*

Electro/88 129

Electro's technical program expands to 54 sessions, 35 of which focus on software.—*Dan Strassberg, Associate Editor*

Electro/88 Products 139

Decade 90: The future of system design—Part 5 180

Fault-tolerant design techniques developed originally for aerospace systems will pervade the electronics industry as customers demand the utmost in reliability from every electronic product, even those intended for use on Earth.—*Steven H Leibson, Regional Editor*

Silicon compilers tame 10,000-gate-plus ASICs, gate arrays 195

Silicon compilation offers a new paradigm for the management of large complex designs.—*William J Stenzel, Tandem Computers Inc*

Take care when choosing controllers for flat-panel displays 209

Emissive flat-panel displays are well suited for applications requiring minimum size and weight. To optimize overall system performance, you must select a controller that's right for the job, keeping in mind that a flat-panel display's control requirements are more stringent than are a CRT's.—*Colin McManus, Digital Electronics Corp*

Mini dc/dc supplies simplify redundancy in parallel systems 225

Miniature, on-card dc/dc converters make it possible to design parallel-redundant systems that offer higher efficiency than that attainable from conventional UPS designs.—*Lars Thorsell, Rifa Power Products*

Continued on page 7

EDN®(ISSN 0012-7515) is published 38 times a year (biweekly with 1 additional issue a month) by Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M McDermott, President; Frank Sibley, Electronics/Computer Group Vice President; Jerry D Neth, Vice President/Publishing Operations; J J Walsh, Financial Vice President/Magazine Division; Thomas J Dellamaria, Vice President/Production and Manufacturing. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5191. Telephone: (303) 388-4511. Second-class postage paid at Denver, CO 80206-5191 and additional mailing offices. POSTMASTER: Send address corrections to EDN® at the Denver address. EDN® copyright 1988 by Reed Publishing USA; Saul Goldweitz, Chairman; Ronald G Segel, President and Chief Executive Officer; Robert L Krakoff, Executive Vice President; William M Platt, Senior Vice President. Annual subscription rates for nonqualified people: USA, $100/year; Canada/Mexico, $115/year; Europe air mail, $135/year; all other nations, $135/year for surface mail and $210/year for air mail. Except for special issues where price changes are indicated, single copies of regular issues are available for $6, $8, and $10 (USA, Canada/Mexico, and foreign). Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5191.

Choice. Performance. HP beam lead PIN diodes.

we never stop asking

"What if..."

From circling satellites to aircraft electronics, the performance choice in beam lead PIN diodes is Hewlett-Packard. No one offers you more variety or more ways to meet your target specifications...all backed by the most extensive published reliability test data in the industry.

Capabilities available to you include: the lowest RC product on the market; the broadest selection of Rs, Cj and switching speeds; unparalleled low resistance at low bias; exceptionally low trr; high beam strength; low capacitance; standard TXV level tested parts. Plus, HP is the only company that *guarantees* minimum and maximum capacitance windows for HPND-4018/28/38 devices.

Don't spend the day on the phone placing orders to half-a-dozen suppliers! Just one phone call to the HP sales office nearest you (ask for the Components Department) will give you the most choice, the best choice, the right choice...every time. Or, for a complete set of data sheets simply circle our number on the reader service card in this issue.

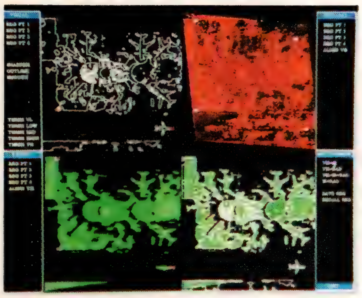
HEWLETT PACKARD

CG08709

Continued from page 5

EDN

April 28, 1988



Your choice of machine-vision equipment *depends on your application and the amount of money you want to spend (pg 55).*

TECHNOLOGY UPDATE

Sophisticated hardware and software beget efficient machine-vision systems 55

Because of recent developments in machine-vision technology, you no longer need a lot of specialized knowledge to develop vision systems that let machines search for and differentiate among patterns.—*J D Mosley, Regional Editor*

Advances in speed and voltage ratings enhance applications for optocouplers 75

The widespread use of optocouplers is testimony not only to their long history, but to the great variety of types for sale.—*Dave Pryce, Associate Editor*

PRODUCT UPDATE

Software package 89
Mid-range development tools 90
Menu-driven digital multimeter 92

DESIGN IDEAS

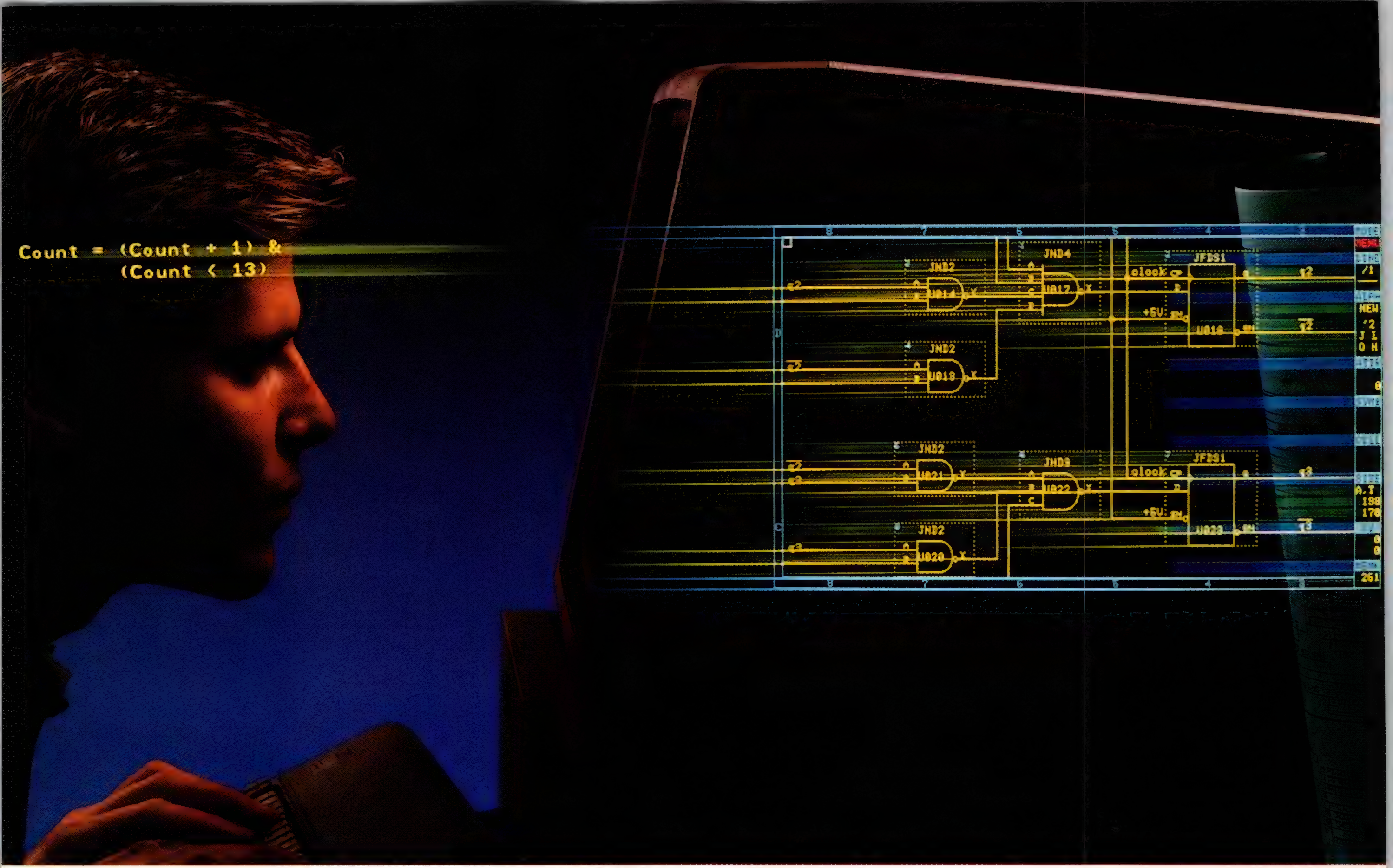
Electronic thermometer has 10-mV/°F output 237
Add two 16-bit pointers to the 8031 µP 238
Spare inverters form a transparent D latch 238
Adders enable detection of multiple inputs 240
Program aids resistive-divider calculations 240
1987 Design Idea Grand Prize Winner 246

Continued on page 9

EDN magazine now offers Express Request, a convenient way to retrieve product information by phone. See the Reader Service Card in the front for details on how to use this free service.

Express Request

Cahners Publishing Company, A Division of Reed Publishing USA ☐ Specialized Business Magazines for Building & Construction ☐ Manufacturing ☐ Foodservice & Lodging ☐ Electronics & Computers ☐ Interior Design ☐ Printing ☐ Publishing ☐ Industrial Research & Technology ☐ Health Care ☐ and Entertainment. Specialized Consumer Magazines: ☐ American Baby ☐ and Modern Bride.



AUTOMATIC SCHEMATIC.

FUTUREDESIGNER: DRAW LESS. DESIGN MORE. Introducing FutureDesigner™ — the only advanced design entry workstation that lets you describe your circuit in compact, high-level terms and create more complex designs faster. FutureDesigner's flexible, new techniques encourage creativity and experimentation, helping you produce innovative products quickly and more accurately.

MULTIPLE DESIGN ENTRY MODES FOR SPEED AND FLEXIBILITY. Describe your circuit with any combination of structural and behavioral representations. Use schematics to enter the structural portions of the design, such as data paths in a memory array. For portions easier to describe behaviorally, like sequencers or decoders, simply enter equations, truth tables or state diagrams using on-screen input forms.

ADVANCED DESIGN VERIFICATION HELPS YOU GET IT RIGHT THE FIRST TIME. For the behavioral portions of your design, use FutureDesigner as a "what if" tool to try different design approaches. Immediately verify that your circuit works as you intended. For the structural portions, design check tools detect and help you correct connectivity and other common design errors. Together these features significantly shorten the design iteration cycle.

LOGIC SYNTHESIS CONVERTS YOUR EQUATIONS INTO SCHEMATICS. Once you've entered equations, state diagrams or truth tables, FutureDesigner's logic synthesizer eliminates redundant circuitry and optimizes your design for size/speed trade-offs. FutureDesigner is the only design entry workstation that will then automatically produce the correct schematics and integrate them with the total structural design.

MORE CHOICES IN TECHNOLOGIES, VENDORS AND SYSTEMS. FutureDesigner is technology independent. Choose the most convenient mix of TTL, PLDs, gate arrays or other ASICs from a wide range of semiconductor manufacturers. You can easily migrate from one technology to another without redesign.

FutureDesigner output is an industry standard, widely accepted by engineering service bureaus and semiconductor vendors. You'll also have access to both FutureNet® and other CAD systems for simulation and PCB layout.

Call us today and learn how a FutureDesigner workstation gives you the flexibility and accuracy to design innovative products faster.

1-800-247-5700
Dept. 117

Data I/O Corporation 10525 Willows Road N.E., P.O. Box 97046, Redmond, WA 98073-9746, U.S.A. (206) 881-6444/Telex 15-2167
FutureNet 9310 Topanga Canyon Boulevard, Chatsworth, CA 91311-7528 (818) 700-0691/Telex 910-494-2681
Data I/O Canada 6725 Airport Road, Suite 302, Mississauga, Ontario L4V 1V2 (416) 678-0761/06968133
Data I/O Europe World Trade Center, Strawinskylaan 633, 1077 XX Amsterdam, The Netherlands (20) 622866/Telex 16616 DATIO NL
Data I/O Japan Sumitomoseimei Higashishinbashi Bldg., 8F, 2-1-7, Higashi-Shinbashi, Minato-ku, Tokyo 105, Japan
(03) 432-6991/Telex 2522685 DATAIO J

FutureNet
A Data I/O Company

©1987 Data I/O Corporation.

CIRCLE NO 80

Continued from page 7

VP/Publisher
F Warren Dickson
VP/Associate Publisher/Editorial Director
Roy Forsberg
Editor
Jonathan Titus
Managing Editor
John S Haystead
Assistant Managing Editor
Joan Morrow
Special Projects
Gary Legg
Home Office Editorial Staff
275 Washington St, Newton, MA 02158
(617) 964-3030
Tom Ormond, *Senior Editor*
Deborah Asbrand, *Associate Editor*
Joanne Clay, *Associate Editor*
Tarlton Fleming, *Associate Editor*
John A Gallant, *Associate Editor*
Clare Mansfield, *Associate Editor*
Dave Pryce, *Associate Editor*
Cynthia B Rettig, *Associate Editor*
Charles Small, *Associate Editor*
Dan Strassberg, *Associate Editor*
Chris Terry, *Associate Editor*
Ron Gilbert, *Staff Editor*
Valerie Lauzon, *Staff Editor*
Helen McElwee, *Staff Editor*
Steven Paul, *Senior Production Editor*
Editorial Field Offices
Margery S Conner, *Regional Editor*
Los Osos, CA: (805) 528-0833
Doug Conner, *Regional Editor*
Los Osos, CA: (805) 528-0865
Bob Cushman, *Special Features Editor*
Port Washington, NY: (516) 944-6524
Steven H Leibson, *Regional Editor*
Boulder, CO: (303) 494-2233
J D Mosley, *Regional Editor*
Arlington, TX: (817) 465-4961
Richard A Quinnell, *Regional Editor*
San Jose, CA: (408) 296-0868
David Shear, *Regional Editor*
San Jose, CA: (408) 997-5452
Maury Wright, *Regional Editor*
San Diego, CA: (619) 748-6785
Peter Harold, *European Editor*
0603-630782
(St Francis House, Queens Rd,
Norwich, Norfolk NR1 3PN, UK)
Contributing Editors
Robert Pease, Bob Peterson,
Don Powers, Bill Travis
Editorial Services
Kathy Leonard, *Office Manager*
Loretta Curcio, Nancy Weiland,
Sharon Gildea
Art Staff
Kathleen Ruhl, *Art Director*
Ken Racicot, *Assistant Art Director*
Chin-Soo Chung, *Graphic Designer*
Cathy Filipski, *Graphic Designer*
Production/Manufacturing Staff
William Tomaselli, *Production Supervisor*
Donna Pono, *Production Manager*
Andrew A Jantz, *Production Assistant*
Linda Lepordo, *Production Assistant*
Diane Malone, *Composition*
Graphics Director
Norman Graf
VP/Production/Manufacturing
Wayne Hulitzky
Director of Production/Manufacturing
John R Sanders
Director of Research
Deborah Virtue
Marketing Communications
Janice Molinari, *Manager*
Jennifer Ware, *Communications Manager*
Anne Foley, *Promotion Assistant*

EDITORIAL 47

Evaluating the strength of Pacific-rim countries involves more than economics. Social and political structures require a close look, too.

NEW PRODUCTS

Computers & Peripherals 249
Components & Power Supplies 267
Integrated Circuits 297
CAE & Software Development Tools 308
Test & Measurement Instruments 314

PROFESSIONAL ISSUES 351

IEEE database service encourages entrepreneurial urges.—*Deborah Asbrand, Associate Editor*

LOOKING AHEAD 369

US capacitor sales are on the way up . . . LAN market to grow at 20% rate through '91.

DEPARTMENTS

News Breaks 21
News Breaks International 24
Signals & Noise 32
Calendar 38
Readers' Choice 98
Leadtime Index 104
Literature 338
Business/Corporate Staff 348
Career Opportunities 354
Advertisers Index 365

SIEMENS

An abundance of housings,
voltage classes, polarities
and functions:

Small-signal transistors in SIPMOS technology

SIPMOS® small-signal transistors are direct offshoots of advanced Siemens Power Metal Oxide Semiconductor technology. They complement the bipolar range and offer an abundance of housings, voltage classes, polarities and functions:
p channel, n channel, enhancement or depletion modes, logic-level transistors or high-voltage transistors, leaded and SMD versions.

SIPMOS small-signal transistors are planar MOS transistors with vertical current flow. They're ideal tools for upgrading your circuitry and enable simplified design with fewer components. And because the characteristics of a transistor depend so much on the channel zone, SIPMOS transistors are designed to have an especially favorable width/length ratio in this zone. The result: low on-state resistances $R_{DS(on)}$ and high drain currents I_D.

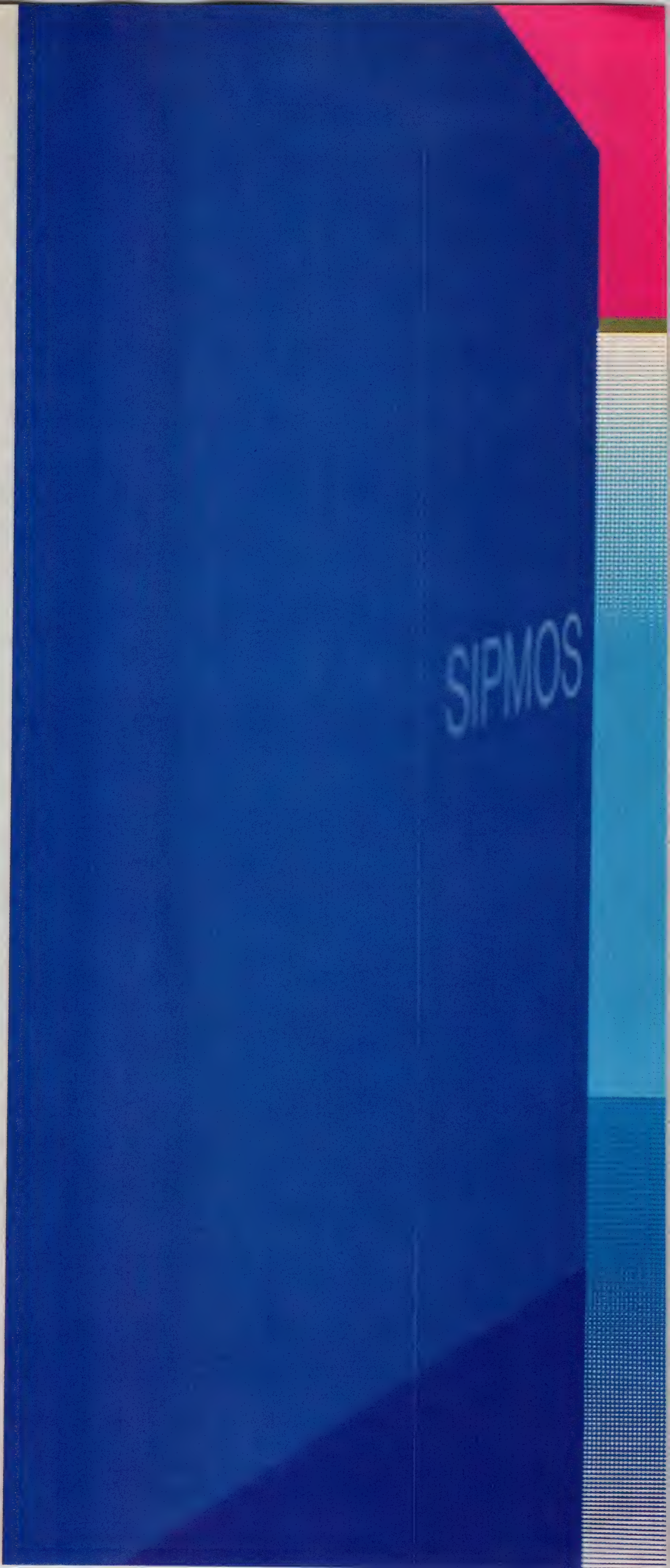
Revolutionize your circuits. Delivery of SIPMOS components is fast and dependable.

Siemens AG, Components Group,
Balanstrasse 73, D-8000 Munich 80

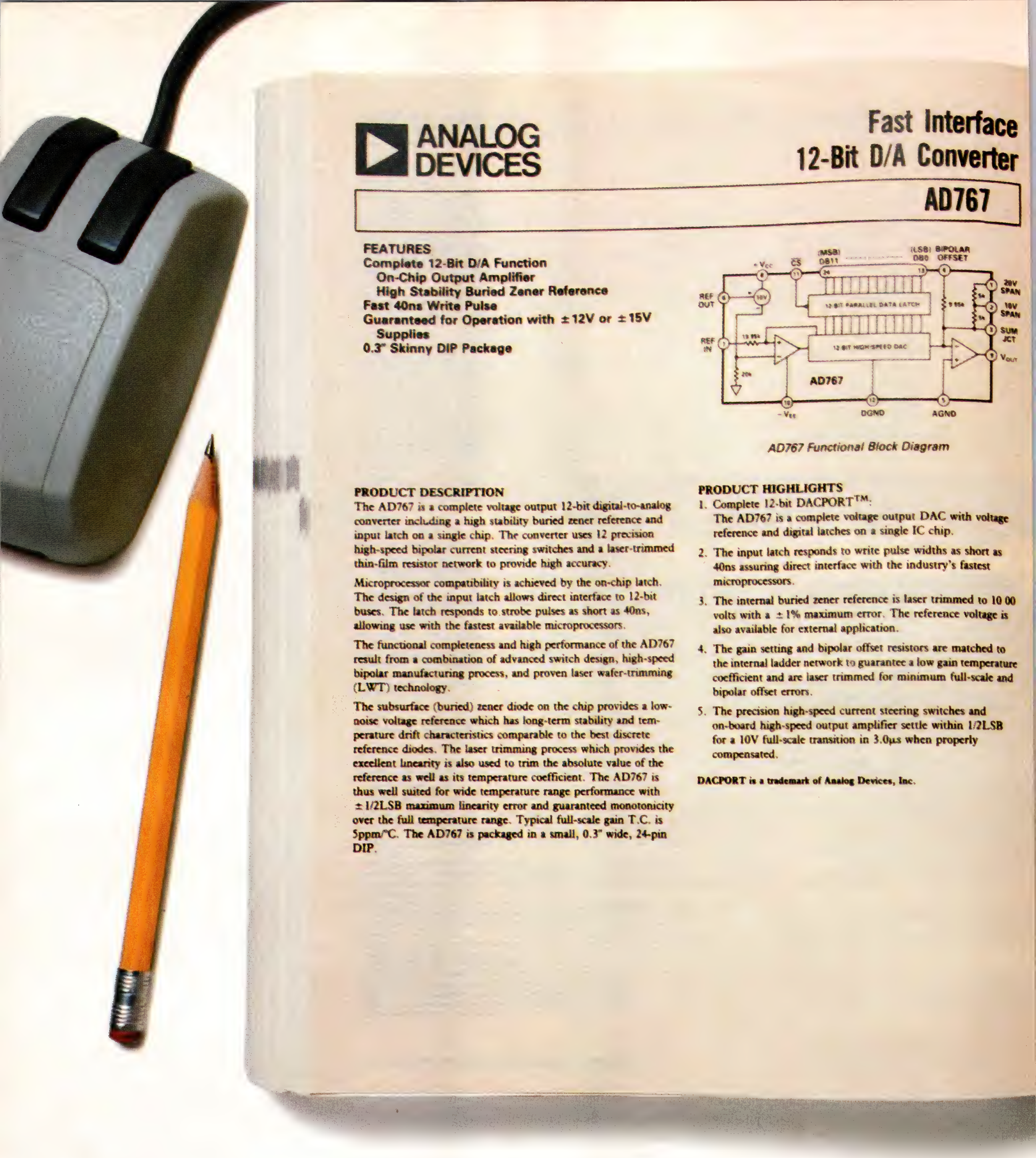
TopTech Components: Siemens

CIRCLE NO 81

12/Z030e



Enhancement
p-Channel
Depletion
-Channel
Logic
Level
HIGH VOLTAGE
SMD



ANALOG DEVICES

Fast Interface 12-Bit D/A Converter

AD767

FEATURES

Complete 12-Bit D/A Function
- **On-Chip Output Amplifier**
- **High Stability Buried Zener Reference**

Fast 40ns Write Pulse

Guaranteed for Operation with ±12V or ±15V Supplies

0.3" Skinny DIP Package

(MSB) DB11
(LSB) DB0
BIPOLAR OFFSET
+Vcc
CS
REF OUT
REF IN
10V
12-BIT PARALLEL DATA LATCH
12-BIT HIGH-SPEED DAC
20V SPAN
10V SPAN
SUM JCT
VOUT
AD767
−VEE
DGND
AGND

AD767 Functional Block Diagram

PRODUCT DESCRIPTION

The AD767 is a complete voltage output 12-bit digital-to-analog converter including a high stability buried zener reference and input latch on a single chip. The converter uses 12 precision high-speed bipolar current steering switches and a laser-trimmed thin-film resistor network to provide high accuracy.

Microprocessor compatibility is achieved by the on-chip latch. The design of the input latch allows direct interface to 12-bit buses. The latch responds to strobe pulses as short as 40ns, allowing use with the fastest available microprocessors.

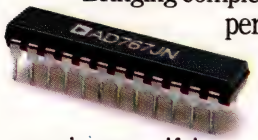
The functional completeness and high performance of the AD767 result from a combination of advanced switch design, high-speed bipolar manufacturing process, and proven laser wafer-trimming (LWT) technology.

The subsurface (buried) zener diode on the chip provides a low-noise voltage reference which has long-term stability and temperature drift characteristics comparable to the best discrete reference diodes. The laser trimming process which provides the excellent linearity is also used to trim the absolute value of the reference as well as its temperature coefficient. The AD767 is thus well suited for wide temperature range performance with ±1/2LSB maximum linearity error and guaranteed monotonicity over the full temperature range. Typical full-scale gain T.C. is 5ppm/°C. The AD767 is packaged in a small, 0.3" wide, 24-pin DIP.

PRODUCT HIGHLIGHTS

1. Complete 12-bit DACPORT™:
   The AD767 is a complete voltage output DAC with voltage reference and digital latches on a single IC chip.
2. The input latch responds to write pulse widths as short as 40ns assuring direct interface with the industry's fastest microprocessors.
3. The internal buried zener reference is laser trimmed to 10.00 volts with a ±1% maximum error. The reference voltage is also available for external application.
4. The gain setting and bipolar offset resistors are matched to the internal ladder network to guarantee a low gain temperature coefficient and are laser trimmed for minimum full-scale and bipolar offset errors.
5. The precision high-speed current steering switches and on-board high-speed output amplifier settle within 1/2LSB for a 10V full-scale transition in 3.0µs when properly compensated.

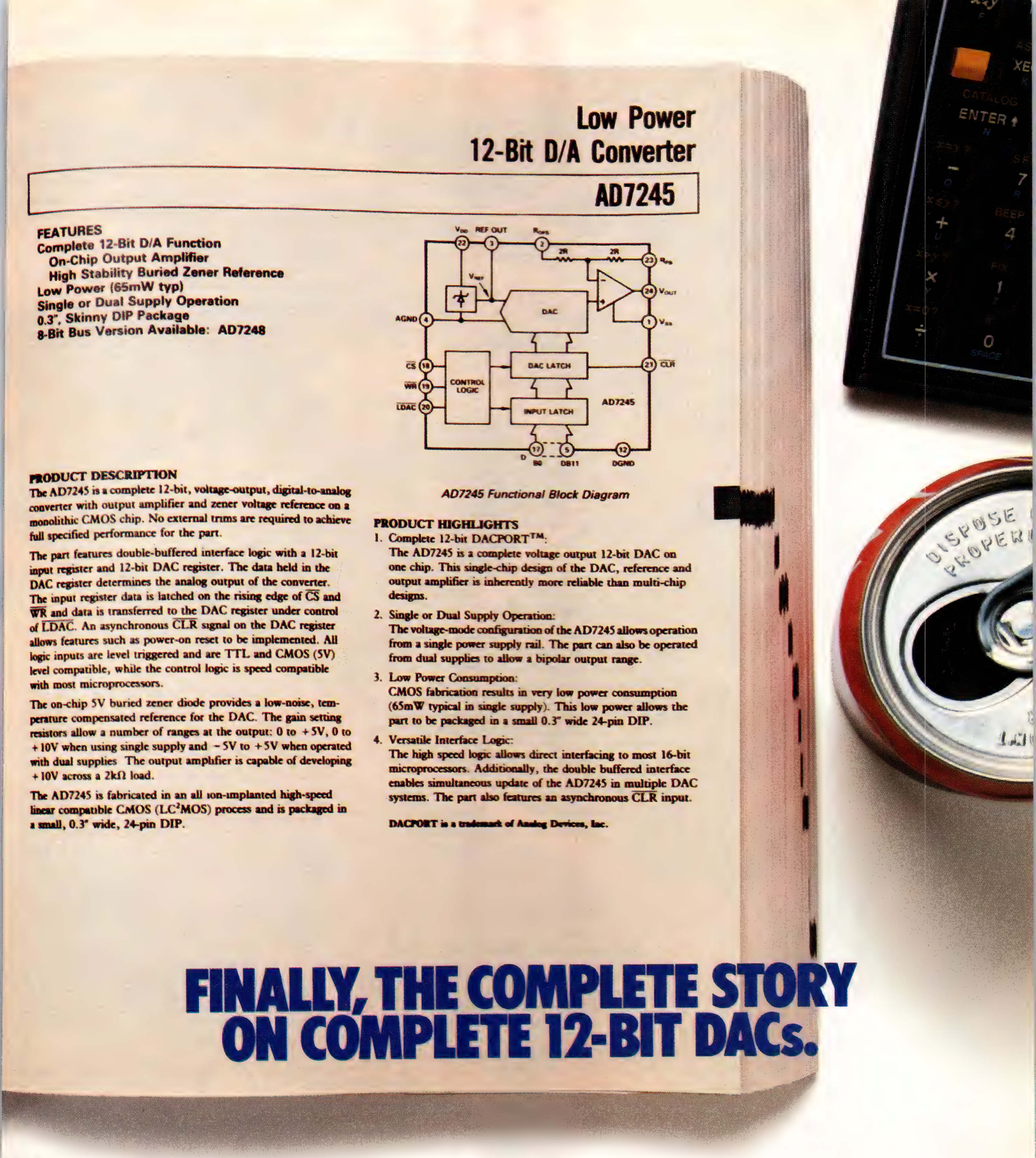
DACPORT is a trademark of Analog Devices, Inc.



Bringing complete 12-bit DAC functionality and performance to your designs no longer requires having to deal with all the problems associated with external components. Instead, it simply requires specifying our new AD767 or AD7245.

Both the AD767 and AD7245 feature an on-chip stable buried Zener reference, output amplifier and microprocessor interface logic. And these complete functions come packed into skinny 0.3″ DIPs. All this means you no longer have to deal with error budgets, product characterizations, or space constraints related to external components.

If digital interface speed is what you're after, the AD767 responds to pulse widths as short as 40ns, allowing it to be used with today's fastest processors. On the other


CR
V_DD
REF OUT
R_OFS
2R
2R
R_FB
V_REF
V_OUT
DAC
AGND
V_SS
CS
WR
LDAC
CONTROL LOGIC
DAC LATCH
INPUT LATCH
CLR
AD7245
DB0
DB11
DGND
22
3
2
23
24
4
1
18
19
20
21
17
5
12

Low Power 12-Bit D/A Converter

AD7245

FEATURES
Complete 12-Bit D/A Function
  On-Chip Output Amplifier
  High Stability Buried Zener Reference
Low Power (65mW typ)
Single or Dual Supply Operation
0.3", Skinny DIP Package
8-Bit Bus Version Available: AD7248

PRODUCT DESCRIPTION

The AD7245 is a complete 12-bit, voltage-output, digital-to-analog converter with output amplifier and zener voltage reference on a monolithic CMOS chip. No external trims are required to achieve full specified performance for the part.

The part features double-buffered interface logic with a 12-bit input register and 12-bit DAC register. The data held in the DAC register determines the analog output of the converter. The input register data is latched on the rising edge of $\overline{CS}$ and $\overline{WR}$ and data is transferred to the DAC register under control of $\overline{LDAC}$. An asynchronous $\overline{CLR}$ signal on the DAC register allows features such as power-on reset to be implemented. All logic inputs are level triggered and are TTL and CMOS (5V) level compatible, while the control logic is speed compatible with most microprocessors.

The on-chip 5V buried zener diode provides a low-noise, temperature compensated reference for the DAC. The gain setting resistors allow a number of ranges at the output: 0 to +5V, 0 to +10V when using single supply and −5V to +5V when operated with dual supplies. The output amplifier is capable of developing +10V across a 2kΩ load.

The AD7245 is fabricated in an all ion-implanted high-speed linear compatible CMOS (LC^{2}MOS) process and is packaged in a small, 0.3" wide, 24-pin DIP.

AD7245 Functional Block Diagram

PRODUCT HIGHLIGHTS

1. Complete 12-bit DACPORT™:
   The AD7245 is a complete voltage output 12-bit DAC on one chip. This single-chip design of the DAC, reference and output amplifier is inherently more reliable than multi-chip designs.
2. Single or Dual Supply Operation:
   The voltage-mode configuration of the AD7245 allows operation from a single power supply rail. The part can also be operated from dual supplies to allow a bipolar output range.
3. Low Power Consumption:
   CMOS fabrication results in very low power consumption (65mW typical in single supply). This low power allows the part to be packaged in a small 0.3" wide 24-pin DIP.
4. Versatile Interface Logic:
   The high speed logic allows direct interfacing to most 16-bit microprocessors. Additionally, the double buffered interface enables simultaneous update of the AD7245 in multiple DAC systems. The part also features an asynchronous $\overline{CLR}$ input.

DACPORT is a trademark of Analog Devices, Inc.

FINALLY, THE COMPLETE STORY ON COMPLETE 12-BIT DACs.

hand, if low power dissipation is critical to your application, the LC^{2}MOS AD7245 consumes only 65mW. There's also an 8-bit bus version of the AD7245 (the AD7248) that loads in two bytes.

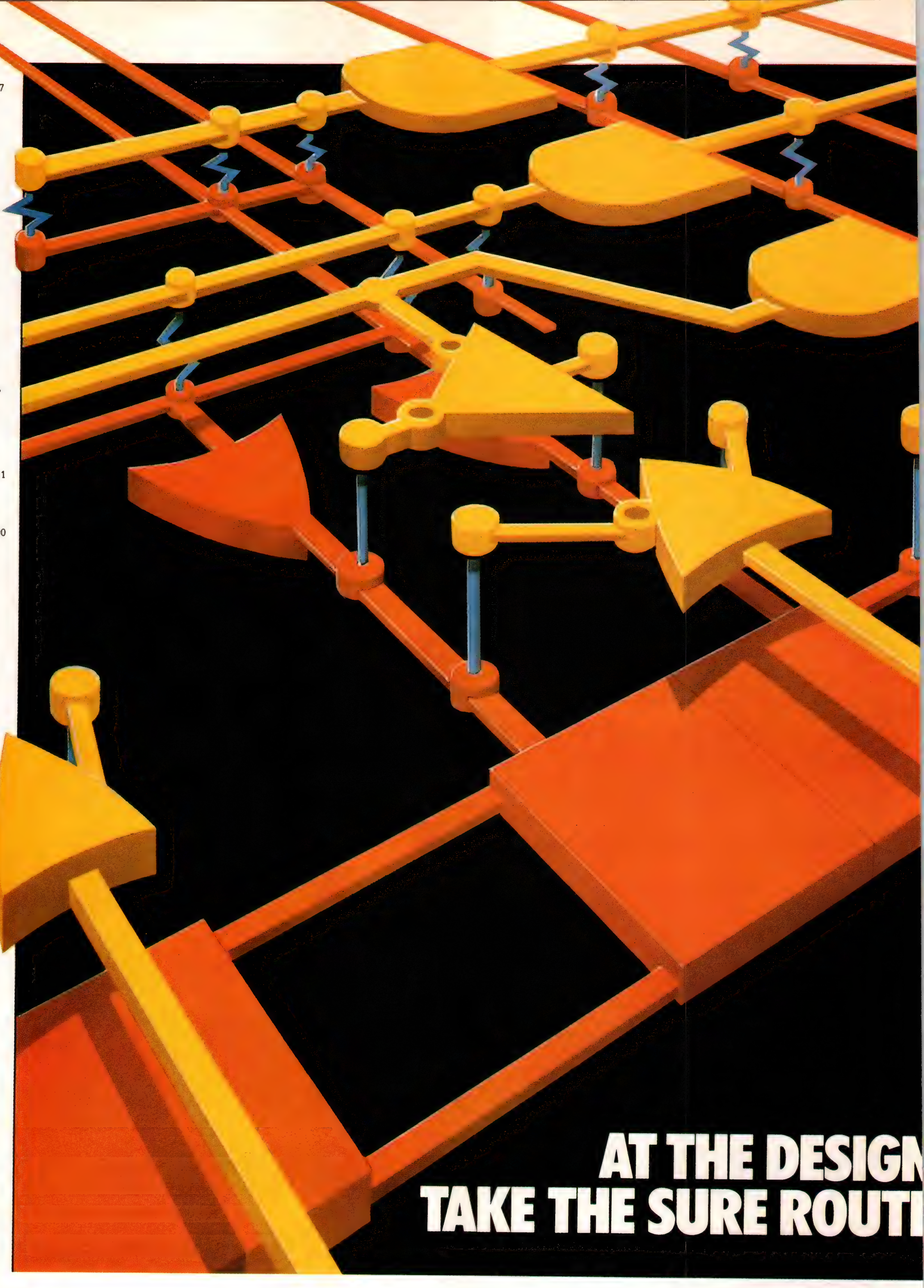
To find out how the AD767 and AD7245 can tend to your complete 12-bit DAC needs, contact the Analog Devices office nearest you.

ANALOG DEVICES

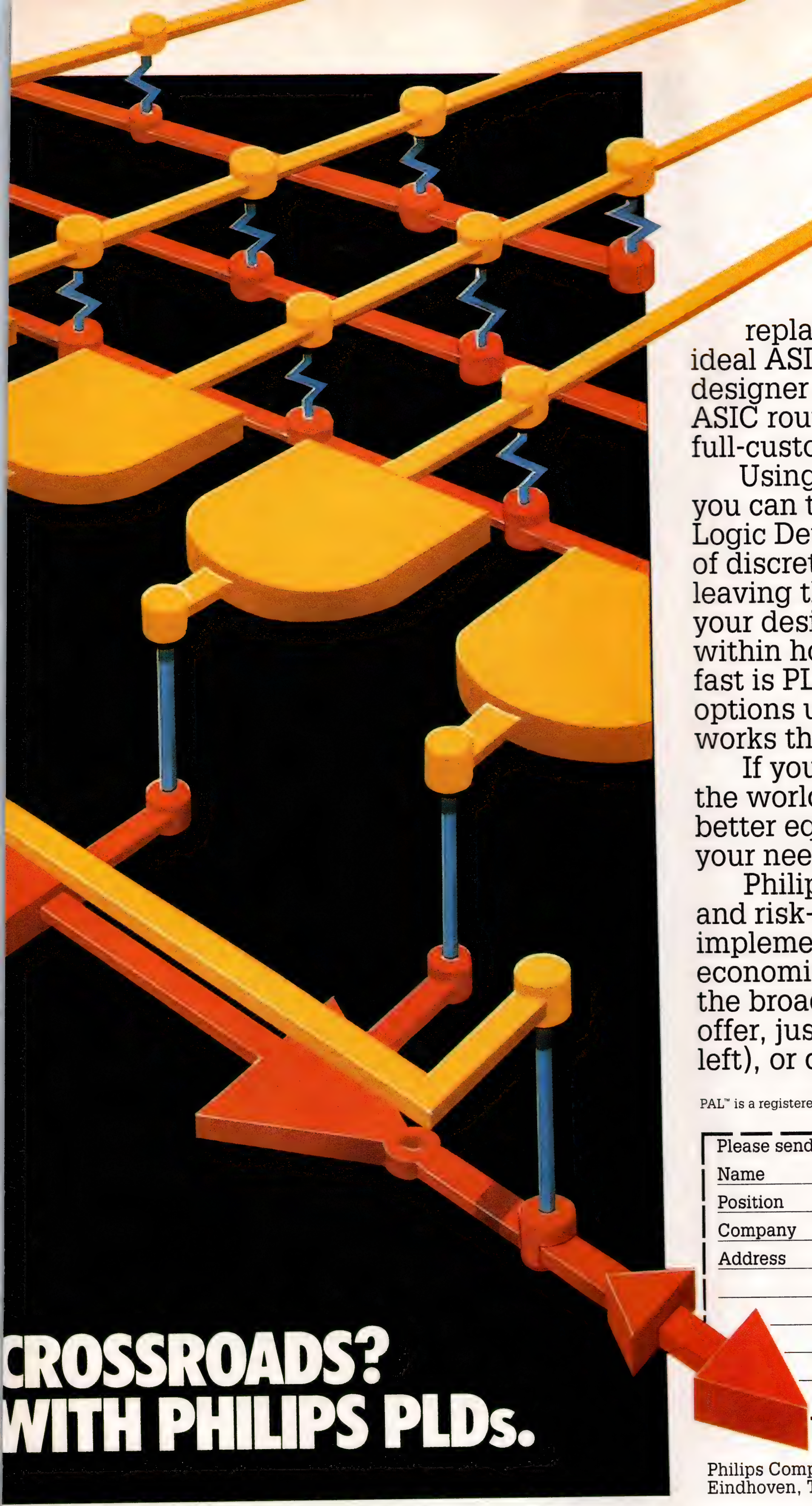
Analog Devices, Inc., One Technology Way, P. O. Box 9106, Norwood, MA 02062-9106; Headquarters: (617) 329-4700; California: (714) 641-9391, (619) 268-4621, (408) 559-2037; Colorado: (303) 590-9952; Maryland: (301) 992-1994; Ohio: (614) 764-8795; Pennsylvania: (215) 643-7790; Texas: (214) 231-5094; Washington: (206) 251-9550; Austria: (222) 885504; Belgium: (3) 237 1672; Denmark: (2) 845800; France: (1) 4687-34-11; Holland: (1620) 81500; Israel: (052) 28995; Italy: (2) 6883831, (2) 6883832, (2) 6883833; Japan: (3) 263-6826; Sweden: (8) 282740; Switzerland: (22) 31 57 60; United Kingdom: (932) 232222; West Germany: (89) 570050

CIRCLE NO 83

Argentina
Buenos Aires
(01) 541 – 7141 to 7747
Australia
Artarmon, N.S.W.
(02) 439 3322
Austria
Wien
(0222) 60101-820
Belgium
Bruxelles
(02) 525 61 11
Brazil
Sao Paulo
(011) 211-2600
Canada
Scarborough
(416) 292-5161
Signetics Etobicoke
(416) 626-6676
Chile
Santiago
(02) 77 38 16
Colombia
Bogota, D.E.
(01) 2 49 7624
Denmark
Copenhagen
(01) 54 11 33
Finland
Helsinki
(90) 1 72 71
France
Issy-Les-Moulinéaux,
Cedex
(01) 40 93 80 00
Germany
(Fed. Republic)
Hamburg
(040) 3296-0
Greece
Tavros
(01) 48 94 339/4894 911
Hong Kong
Kwai Chung
(0)-24 51 21
India
Bombay
(022) 4930311/4930590
Indonesia
Jakarta
(021) 51 79 95
Ireland
Dublin
(01) 69 33 55
Italy
Milano
(02) 6752.1
Japan
Signetics Japan Ltd.
Tokyo (03) 230-1521
Korea (Republic of)
Seoul
(02) 794-5011
Malaysia
Pulau Pinang
(04) 87 00 44
Netherlands
Eindhoven
(040) 78 37 49
New Zealand
Auckland
(09) 605-914
Norway
Oslo
(02) 68 02 00
Pakistan
Karachi
(021) 72 57 72
Peru
Lima
(014) 707080
Philippines
Makati-Rizal
(02) 86 89 51 to 59
Portugal
Lisboa Codex
(019) 68 31 21
Singapore
Singapore
35 02 000
South Africa
Johannesburg
(011) 402-4600/07
Spain
Barcelona
(03) 301 63 12
Sweden
Stockholm
(08) 7821000
Switzerland
Zürich
(01) 488 22 11
Taiwan
Taipei
(02) 7120500
Thailand
Bangkok
(02) 233-6330-9
Turkey
Istanbul
(01) 143 59 10
United Kingdom
London
(01) 580 6633
United States
Signetics Corporation
Sunnyvale
(408) 991-2000
Uruguay
Montevideo
(02) 98 53 95
Venezuela
Caracas
(02) 239 39 31



PHILIPS


CROSSROADS?
WITH PHILIPS PLDs.

Philips offer you a full range of low-cost, proven, customer-Programmable Logic Devices and PAL™ replacements. Philips PLDs are the ideal ASIC entry point for the digital designer – the first step on the Philips ASIC route that takes you all the way to full-custom design.

Using our powerful AMAZE software you can tailor customer-Programmable Logic Devices yourself to perform a host of discrete logic functions. Without leaving the design lab, you can create your design and implement it in silicon within hours. And so economical and fast is PLD design, you can try several options until you get the design that works the way you want it to.

If you need support and training, the world-wide Philips organisation is better equipped than anyone to meet your needs.

Philips PLDs give you the freedom and risk-free flexibility you need to implement your designs as quickly and economically as possible. To discover the broad range of PLDs Philips have to offer, just call your local partner (see left), or complete and post the coupon.

PAL™ is a registered trademark of MMI.

Please send me the Philips PLD brochure.

Name ____________

Position ____________

Company ____________

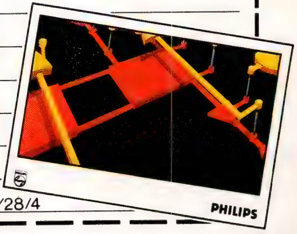
Address ____________

____

____

____

Tel. ____________ EDN/28/4



Philips Components Division, P.O. Box 218, 5600 MD
Eindhoven, The Netherlands. Telex: 35000 phtc nl/nljevmc.

For customer PLDs, the name is Philips.

PHILIPS

CIRCLE NO 84

Choose Teledyne First!

AUTHORIZED DISTRIBUTORS

Alabama

Marshall Industries
Huntsville, AL
(205) 881-9235

Quality Components
Huntsville, AL
(205) 830-1881

Arizona

Future/Cetec Electronics
Phoenix, AZ
(602) 968-7140

Marshall Industries
Phoenix, AZ
(602) 496-0290

California

All American
Torrance, CA
(213) 320-0240

All American
San Jose, CA
(408) 287-0190

Future Electronics
San Jose, CA
(408) 434-1114

Marshall Industries
Milpitas, CA
(408) 942-4600

Marshall Industries
Rancho Cordova, CA
(916) 635-9700

Future/Cetec Electronics
Chatsworth, CA
(818) 700-0914

Marshall Industries
Chatsworth, CA
(818) 407-0101

Marshall Industries
El Monte, CA
(818) 459-5500

Future/Cetec Electronics
Irvine, CA
(714) 250-4141

Marshall Industries
Irvine, CA 92718
(714) 859-5050

Future/Cetec Electronics
San Diego, CA
(619) 278-5020

Marshall Industries
San Diego, CA
(619) 578-9606

Micro-Die Systems
Torrance, CA
(213) 373-0687

Colorado

Future Electronics
Westminster, CO
(303) 650-0123

Marshall Industries
Thornton, CO
(303) 451-8383

Connecticut

Future Electronics
Bethel, CT
(203) 743-9594

Marshall Industries
Wallingford, CT
(203) 265-3822

Florida

All American
Miami, FL
(305) 621-8282

Chip Supply
Orlando, FL
(305) 298-7100

Future Electronics
Clearwater, FL
(813) 578-2770

Future Electronics
Altamonte Springs, FL
(305) 767-8414

Marshall Industries
Ft. Lauderdale, FL
(305) 977-4880

Marshall Industries
Altemonte Springs, FL
(305) 767-8585

Marshall Industries
St. Petersburg, FL
(813) 576-1399

Quality Components
Tampa, FL
(813) 854-2614

Georgia

Future Electronics
Norcross, GA
(404) 441-7676

Marshall Industries
Norcross, GA
(404) 923-5750

Quality Components
Norcloss, GA
(404) 449-9508

Illinois

Advent Electronics
Rosemont, IL
(312) 298-4210

Future Electronics
Schaumburg, IL
(312) 882-1255

Marshall Industries
Schaumburg, IL
(312) 490-0155

Indiana

Advent Electronics
Indianapolis IN
(317) 872-4910

Marshall Industries
Indianapolis, IN
(317) 297-0483

Iowa

Advent Electronics
Cedar Rapids, IA
(319) 363-0221

Kansas

Marshall Industries
Lenaxa, KS
(913) 492-3121

Maryland

All American
Rockville, Maryland
(301) 251-1205

Future Electronics
Columbia, MD
(301) 995-1222

Marshall Industries
Gaithersburg, MD
(301) 840-9450

Pyttronic Industries
Savage, MD
(301) 792-0780

Massachusetts

Now Electronics
Framingham, MA
(617) 872-5876

Future Electronics
Westborough, MA
(617) 366-2400

Marshall Industries
Wilmington, MA
(617) 658-0810

Michigan

Advent Electronics
Farmington Hill, MI
(313) 477-1650

Marshall Industries
Livonia, MI
(313) 525-5850

Future Electronics
Detroit, MI
(313) 261-5270

Minnesota

All American
Minneapolis, MN
(612) 884-2220

Marshall Industries
Plymouth, MN
(612) 559-2255

Future Electronics
Eden Praire, MN
(612) 944-2200

Missouri

Marshall Industries
Bridgeton, MO
(314) 291-4650

New Jersey

Future Electronics
Mt. Laurel, NJ
(609) 778-7600

Marshall Industries
Mt. Laurel, NJ
(609) 234-9100

Future Electronics
Fairfield, N.J.
(201) 227-4346

Marshall Industries
Fairfield, NJ
(201) 882-0320

New York

All American
Ronkonkoma, NY
(516) 981-3935

Future Electronics
Liverpool, NY
(315) 451-2371

Future Electronics
Rochester, NY
(716) 272-1120

Marshall Industries
Hauppage, LI, NY
(516) 273-2424

Marshall Industries
Johnson City, NY
(607) 798-1611

Marshall Industries
Rochester, NY
(716) 235-7620

Future Electronics
Hauppauge, NY
(516) 234-4000

North Carolina

Marshall Industries
Raleigh, N.C.
(919) 878-9882

Quality Components
Raleigh, N.C.
(919) 876-7767

Future Electronics
Charlotte, N.C.
(704) 529-5500

Ohio

Hughes-Peters, Inc.
Cincinnati, OH
(513) 351-2000

Hughes-Peters Inc.
Columbus, OH
(614) 294-5351

Marshall Industries
Dayton, OH
(513) 898-4480

Marshall Industries
Solon, OH
(216) 248-1788

Marshall Industries
Westerville, OH
(614) 891-7580

Oklahoma

Quality Components
Tulsa, OK
(918) 664-8812

Oregon

Cetec Future
Beaverton, OR
(503) 645-9454

Marshall
Beaverton, OR
(503) 644-5050

Pennsylvania

Marshall Industries
Pittsburgh, PA
(412) 963-0441

Pyttronic Industries
Montgomeryvill, PA
(213) 643-2850

Texas

All American
Richardson, TX
(800) 541-1435

Future Electronics
Richardson, TX
(214) 437-2437

Marshall Industries
Austin, TX
(512) 837-1991

Marshall Industries
Carrollton, TX
(214) 233-5200

Marshall Industries
Houston, TX
(713) 895-9200

Marshall Industries
El Paso, TX
(915) 593-0706

Marshall Industries
Brownsville, TX
(512) 542-4589

Quality Components
Addison, TX
(214) 733-4300

Quality Components
Austin, TX
(512) 835-0220

Quality Components
Sugarland, TX
(713) 491-2255

Utah

Future Electronics
Salt Lake City, UT
(801) 972-8489

Marshall Industries
Salt Lake, UT
(801) 485-1551

Washington

Future Electronics
Redmond, WA
(206) 881-8199

Marshall Industries
Bellevue, WA
(206) 747-9100

Wisconsin

Marshall Industries
Brookfield, WI
(414) 797-8400

Taylor Electronic Co.
Mequon, WI
(414) 241-4321

Alberta

Future Electronics
Calgary Alberta
(403) 235-5325

Future Electronics
Edmonton, Alberta
(403) 438-2858

British Columbia

Future Electronics
Vancouver, B.C.
(604) 294-1166

Ontario

Future Electronics
Ottawa, Ontario
(613) 820-8313

Future Electronics
Dowsview, Ontario
(416) 638-4771

Quebec

Future Electronics
Pointe Claire, Quebec
(514) 694-7710

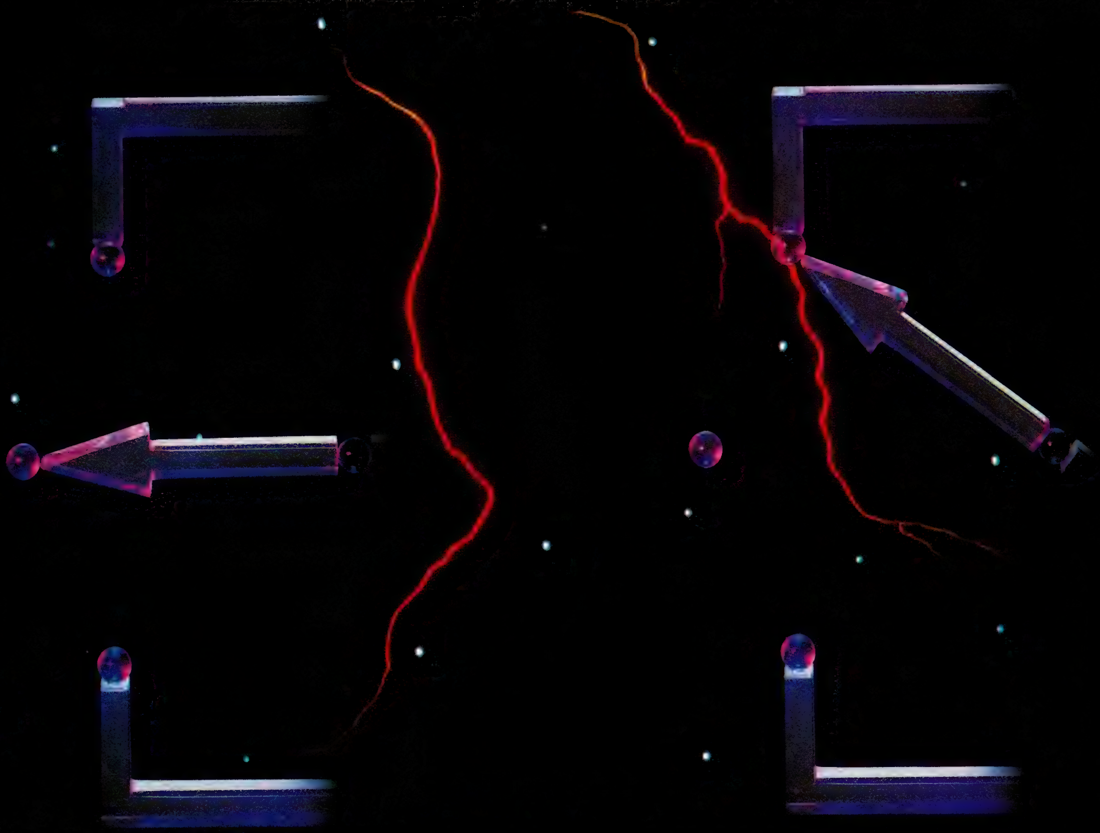
Future Electronics
St. Foy, Quebec
(418) 682-5775

Manitoba

Future Electronics
Winnipeg, Manitoba
(204) 339-0554

TELEDYNE
SEMICONDUCTOR

Seeking
a +5V Supply Voltage Analog Switch?
....They Exist Here!

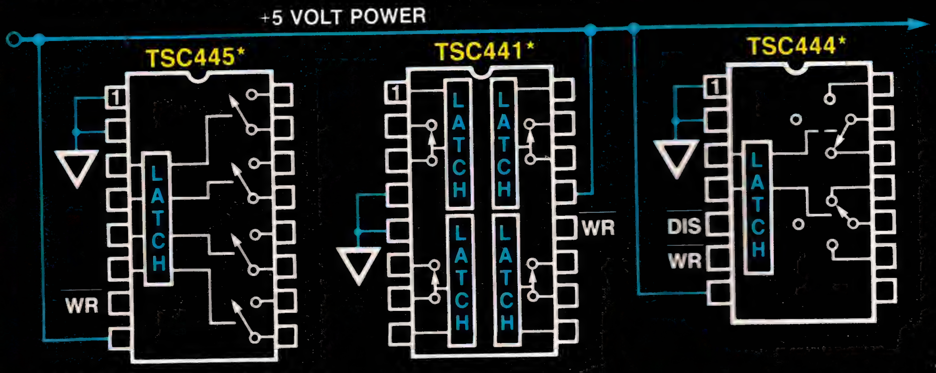


Teledyne Semiconductor's **TSC44X** precision **CMOS** analog switch family sets the standard in low supply voltage switch technology. Sharing the same 5V or ±5V power supply levels modern CMOS data converters and operational amplifiers need, your designs now benefit from low 10 pA switch leakage current, 95 ohm "ON" resistance, and 1.5mW power dissipation. Single supply operation from 3 to 18V for battery powered systems. Full microprocessor compatibility too!

Switch architectures cover all your application needs from quad **SPST** to dual **SPDT**. Normally closed, open and mixed versions. The innovative **TSC444 SPDT** switch features a neutral, switch "OFF" position. On chip latches eliminate external components in μ-processor controlled systems. Disable latches for transparent operation. Standardize on the **TSC44X** family for your job today and tomorrow's breakthrough.

Pin compatible with many old, high supply voltage only parts like the DG221 and AD7590/1/2. Available in DIP or "SO" surface mount technology. Call or write for full information, design help and data sheets. Samples available now.

All devices are backed by Teledyne's reputation for quality, service and support - a reputation earned through 25 leadership years in the semiconductor industry.



*All Configurations Available

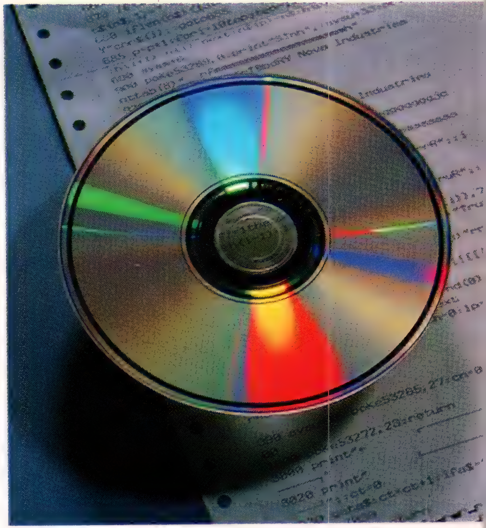
CIRCLE NO 85

1-800-888-9966
415-968-9241

1300 Terra Bella Avenue
Mountain View, CA 94039
TWX: 910-379-6494
FAX: 415-967-1590

TELEDYNE SEMICONDUCTOR

mag



Easy-flowing plastics with high moulding accuracy?

Take a tip from PDO: Talk to Bayer!

Example: Data storage disc made of Makrolon CD 2000

If you're looking for the right material, why not do as the Design Department of Philips-Dupont-Optical did. Talk to Bayer!

For non-erasable optical data storage discs PDO uses the high-performance engineering plastic Makrolon CD 2000. An extremely light, easy-flowing plastic which will produce data storage discs with a very high accuracy of reproduction and very low double refraction.

Bayer offers one of the world's biggest ranges of high-performance engineering plastics:

®Apec (PAR), ®Bayblend (PC + ABS), ®Bayfol (PC blend film), ®Baygal/ Baymidur (PUR cast resin), ®Desmopan (TPUR), ®Durethan (PA 6/PA 66), ®Leguval (UP), ®Lekutherm (EP), ®Makroblend (PC blends), ®Makrofol (PC film), ®Makrolon (PC), ®Novodur (ABS), ®Petlon (PET), ®Pocan (PBT), ®Tedur (PPS).

Whether it's flowability, the highest accuracy of reproduction or other properties you need:

Talk to Bayer – so that material problems become material solutions.

For more information write to:
Bayer AG, AV-Informationsvermittlung
Postfach 80 01 49, D-5000 Köln 80

CIRCLE NO 86

Plastics Business Group

Bayer BAYER

KU 3985 e.i. 544/4.88

Spectrum & Network Analyzer FSAS

Spectrum analysis of the highest standard
Highly sensitive (typ. <−150 dBm) and free of intermodulation (≥100 dB)

Scalar network analysis with 110-dB display range
Transmission and reflection measurements
on crystal or bandstop filters,
on coaxial cables (leakage, attenuation, VSWR) and on lots more

IEC 625 Bus

IEEE 488

- Frequency range 100 Hz to 1.8 GHz (2 GHz)
- Switch-selected output level of tracking generator from −5 to −100 dBm (0.1-dB increments)
- Gain measurement >130 dB
- Attenuation measurement >120 dB
- Separate normalizing for reflection and transmission

E-FS2

Write or call for the data sheet
Spectrum & Network Analyzer FSAS

Rohde & Schwarz
Postfach 80 14 69
D-8000 Muenchen 80
Federal Republic of Germany
Telex 523 703 (rus d)
Tel. internat. + (49 89) 41 29-0

ROHDE & SCHWARZ

CIRCLE NO 89

NEWS BREAKS

EDITED BY JOANNE CLAY

OPTICAL WORM DRIVE STORES 1.2G BYTES ON A CARTRIDGE

The ISi 525GB write-once, read-many (WORM) optical-disk subsystem from Information Storage Inc (Colorado Springs, CO, (303) 579-0460) stores 1.2G bytes of information on its double-sided cartridge. At any one time, an application has access to one side (600M bytes) of the cartridge. In addition, the optical drive features a 6.5M-bps data-transfer rate, which the company claims can provide better throughput than some magnetic hard-disk drives. A subsystem designed to be mounted in an IBM PC or compatible computer costs $5988 and includes the WORM drive, controller board, cables, and software. An enclosed subsystem that adds a power supply and cabinet costs $6188. The company will offer a similar drive with a SCSI interface in August. Meanwhile, the company has lowered the price of its 230M-byte ISi 525WC subsystem from $3995 to $2088.—Steven H Leibson

DSP BOARD AND SUBSYSTEM BOOST HP 9000 WORKSTATION PERFORMANCE

The DSP300 add-in board for Hewlett-Packard's 9000 Series 200/300 workstations employs an AT&T WE-DSP 32 processor to increase the speed at which the workstations perform floating-point operations. Infotek Systems (Anaheim, CA, (714) 956-9300) offers the board as a stand-alone product or as part of the GA300 graphics-accelerator subsystem. The GA300 also includes the BC305 Basic 5.0 compiler and graphics-accelerator software, and it can execute applications such as real-time modeling and animation as much as 40 times faster than the Series 200/300 processor can. Available now, the DSP300 costs $2000 (including the assembler and C compiler) and the GA300 sells for $2395. The company plans to introduce FFT and array-processing subsystems based on the DSP300 in the third quarter of 1988.—Maury Wright

MENU-DRIVEN DMM INCLUDES BAR GRAPH AND FREQUENCY COUNTER

The Model 560 menu-driven digital multimeter from Simpson Electric Co (Elgin, IL, (312) 697-2260) is a 2.5-lb, Z80-based instrument that stores 2150 readings in non-volatile, battery-backed RAM. The basic unit costs $2195. The 560's menu interface simplifies the task of selecting storage parameters for the meter's readings. The readings have 5-digit resolution (allowing for 99,999 counts) and a minus sign. A 52-segment bar graph provides real-time voltage and autorange representations that are independent of the decibels or hertz you're measuring, so you can simultaneously take a reading and observe events at the test point in real time.

The DMM features a built-in frequency counter, true-rms ac measurements, fusing on both current inputs, low-forcing-current and high-forcing-current resistance ranges, a diode-test function, high-speed autoranging, a zero function that eliminates lead resistance in readings, digital filtering, a temperature-compensated reference, and digital calibration. The unit also provides a peak-hold function. You can order the 560 with either an RS-232C serial port or a Centronics-compatible parallel port for $2395.—J D Mosley

MONOLITHIC OP AMP OPERATES FROM ±45V SUPPLIES

Burr Brown's (Tucson, AZ, (602) 746-1111) OPA445 monolithic op amp operates from ±45V power supplies and provides an output swing of ±35V into 5-kΩ loads or generates as much as 15 mA with a maximum output swing of ±28V. The laser-trimmed part features a maximum 1-mV offset voltage, a 10-μV offset drift, and a 10V/μsec slew rate. The company offers the device for $3.80 (100) in either a TO-99 package or an 8-pin DIP with industry-standard op-amp pinouts.—Steven H Leibson

NEWS BREAKS

SOFTWARE PACKAGE INOCULATES DISKS AGAINST COMPUTER VIRUSES

After one of its computers became infected with a destructive virus program (sometimes called a Trojan horse program), Sophco Inc (Boulder, CO, (303) 444-1542) added an inoculation module to its $195 Protec software-protection package for computers running MS-DOS version 3.0 and higher. An engineer at the company had downloaded a seemingly innocuous program (an X-rated animated graphics program) from an electronic bulletin board to a computer's hard disk. That program contained an infectious module that installed delayed-action routines into executable software on the hard disk. Later, the routines destroyed the files on the disk.

Protec version 3.2 can safeguard your programs with a protective virus program called Vaccinate, which you install in your executable files with another program called Syringe. The Protec system also includes a decoy program called Canary that you can use to test suspect software. You include Canary on a floppy disk along with the dubious software and run the suspect program. If the Canary program '"dies" after the suspect program finishes, you know there's a virus program on your disk. Sophco has also initiated the Center for Computer Disease Control, which will act as a clearing house for information about such antisocial software.—Steven H Leibson

NONVOLATILE RAMs REQUIRE NO BACKUP BATTERIES

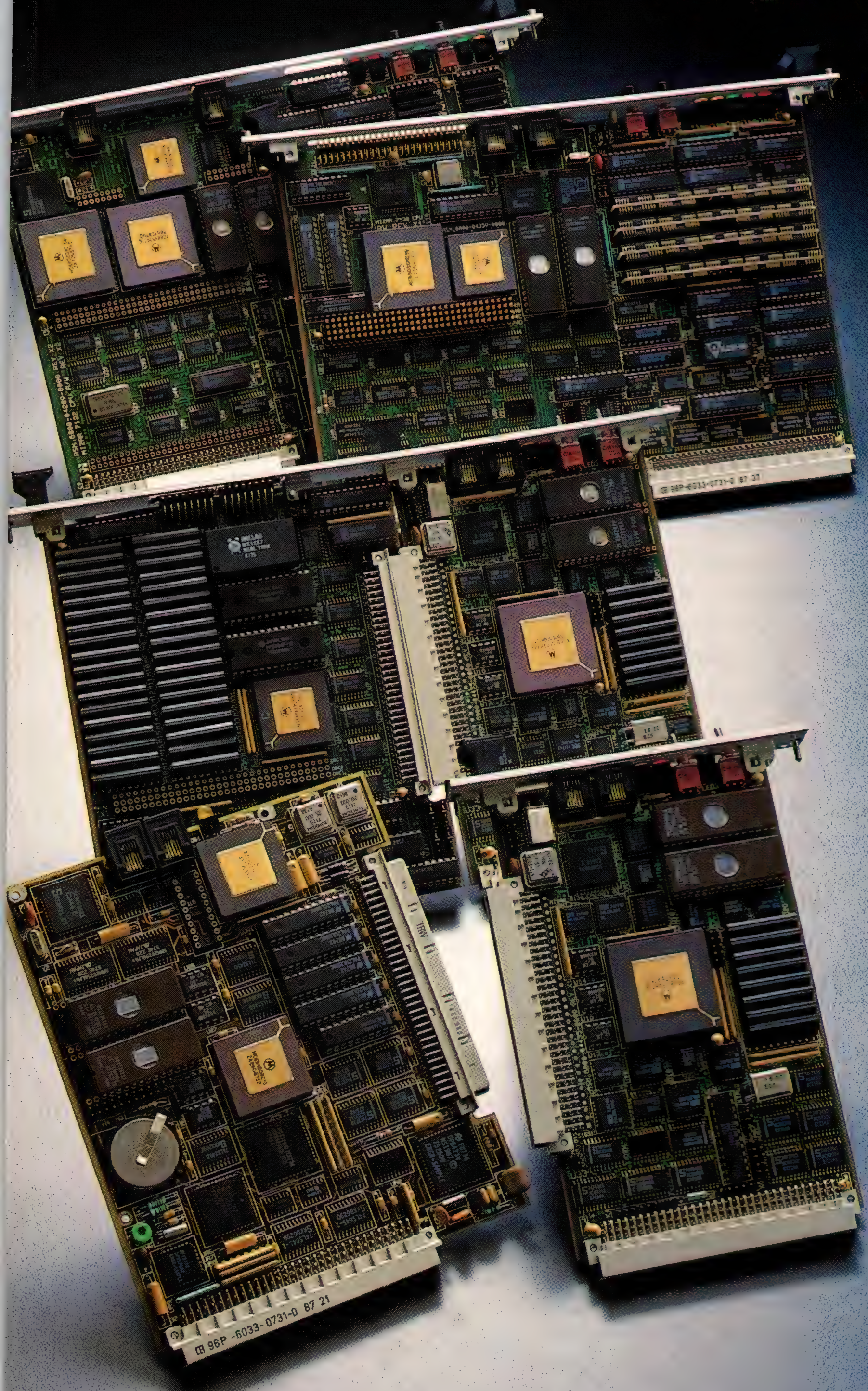
Selected customers are currently evaluating a promising new development in semiconductor memories—nonvolatile RAMs. Dubbed ferroelectric RAMs (FRAMs) or '"shadow" RAMs, the prototype static-RAM devices from Ramtron Corp (Colorado Springs, CO) have a 256×1-bit organization and require no backup batteries. Instead, a pair of special storage capacitors provides backup for each bit cell. These capacitors have a thin-film-ceramic dielectric called "lead zirconate titanate" (PZT), whose bistable polarization allows the indefinite storage of data; you set the polarization state by applying a 2.5V coercive voltage. The initial product (FMx 801) operates on 5V and features 100-nsec read and write operations. Products having higher speed and higher bit density will follow. At present, the company offers the FMx only to qualified customers as a technology-demonstration vehicle, but it expects to have the product available for sale during the third quarter of 1988. The company is also developing nonvolatile dynamic RAMs (based on a 1-transistor memory cell) that have capacities of 256k bits and greater.—Tarlton Fleming

FLASH MEMORIES ALLOW IN-SYSTEM REPROGRAMMING

The 27F64 and 27F256 64k- and 256k-bit flash-memory devices from Intel (Santa Clara, CA, (800) 548-4725) feature in-circuit electrical erasure and reprogramming. You program or erase the devices by writing the appropriate command to a control register and supplying 12V to the programming pin. You program the devices one byte at a time; an erase command erases the entire memory. Erasing the devices takes less than 1 sec; reprogramming them takes less than 4 sec. If you hold the programming pin at 5V, the control register is disabled, allowing normal EPROM read operations. The 27F64 costs $8; the 27F256 is $19.90 (10,000).—Richard A Quinnell

The Application Servers

Build your application with Mizar's new generation of 32-bit microcomputers.



New standards of VME performance.
Mizar presents a new line of microprocessors for VME-based applications. With powerful Motorola 68020 and 68030 CPUs at up to 30 MHz, and the latest in memory interface and surface mount technology, Mizar provides the performance and functionality your application demands.

Platforms for every application.
Mizar designed its new processors with the application developer in mind. Mizar's single-height processors are not only excellent computing engines, but through Mizar's MXbus™, become uniquely configurable to meet specific I/O, memory and processing needs. MZ 8100 Series single-height processors can be transformed into double-height solutions with complete single-board functionality and performance. Similarly, the MZ 7100 Series of double-height processors provide all you expect from a single board computer, and can be tailored with easy-to-use plug-in modules. With either solution, you can start development today.

Superior memory handling.
Mizar's engineers have reduced critical wait-states to zero at 16.7, 20 and 25 MHz in many cases. To enhance multiprocessor system performance, Mizar's new on-card memory arbitration logic frees the CPU during time-consuming memory operations across the VMEbus, allowing concurrent local processing. And for more demanding applications, Mizar's 68030 based MZ 7130 even includes cache options.

Your application demands the latest in 32-bit VME technology. Call Mizar.

1-800-635-0200
Ask for extension 140

Mizar. The shortest distance between concept and reality.

MIZAR

1419 Dunn Drive • Carrollton, TX 75006 • (214) 446-2664
CIRCLE NO 89

NEWS BREAKS: INTERNATIONAL

CAD PACKAGE ALLOWS YOU TO DESIGN AND ORDER RESISTOR NETWORKS

Supplied free of charge on a floppy disk, the Resicalc CAD package from Ericsson Business Area Components (Granna, Sweden, phone (46) 39011020) allows you to design your own resistor networks on an IBM PC. The CAD package, which incorporates the design rules for the company's semicustom Erisistor resistor networks, allows you to design through-hole or surface-mounting SIP (single in-line package) resistor networks, or networks packaged in leadless chip carriers. For each internal resistor, you can specify the absolute value, absolute and relative tolerances, absolute and relative temperature coefficients, and power rating. You then define the leadout connections for each resistor, and the program automatically tells you whether the network is manufacturable as an Erisistor product. If your design isn't feasible, the program suggests parameters you can change to make it manufacturable. In addition to providing an instant guide price for the network, Resicalc allows you to dial up the company's computer on a toll-free line to obtain accurate pricing and delivery information and to place your order.—Peter Harold

CPU CARD PERFORMS 32-BIT DMA TRANSFERS TO VME OR VSB BUS

The FIC8230 intelligent VME Bus board from Creative Electronic Systems SA (Petit-Lancy, Switzerland, TLX 421320) is based on a 16- or 24-MHz 68020 μP and a 68881 or 68882 math coprocessor. The board offers an optional DMA controller that can perform 16- or 32-bit block data transfers across the VME Bus's entire 4G-byte addressing range at data rates as high as 8M bytes/sec. The DMA controller can also transfer 32-bit data over the VSB Bus at data rates in excess of 10M bytes/sec. Another DMA channel allows you to transfer data to or from an 8-bit I/O port, which you can configure for a variety of uses (for instance, you can use it as a SCSI port).

The board has 512k bytes or 1M byte of zero-wait-state CMOS static RAM that's ported to the 68020 and to the VME Bus, and is ported to the VSB Bus via a DMA channel. The board also has 128k bytes of local RAM, and it includes space for as much as 128k bytes of EPROM. Four independent 255×32-bit LIFO/FIFO buffers provide the board with message-passing capabilities. The board's additional facilities include two RS-232C serial I/O ports, a 16-bit timer/counter, and a real-time clock. The board configuration is software programmable. The FIC8230 costs between $4500 and $6000, depending on configuration.—Peter Harold

JAPAN KEY TECHNOLOGY CENTER EARMARKS ¥222M FOR RESEARCH

The Japan Key Technology Center, which is responsible for funding technological developments in the private sector and supporting local information-oriented businesses, has set aside ¥222 million to fund research in various electronic and materials technologies. The organization falls under the jurisdiction of both the Ministry of Posts and Telecommunications (MPT) and the Ministry of International Trade and Industry (MITI). It has designated ¥77 million for research on amorphous magnetic materials and electronic devices and ¥145 million for funding experimental research into high-precision light-detection devices containing superconductive materials, low-voltage EL displays, infrared-image fiber sensors, color filters for use in flat LCDs, and equipment that can measure the effects of electrostatic fields on radio waves.—Joanne Clay

There Will Still Be a Few Uses for Conventional ECL ASICs.

Cold facts: now the highest-density ECL logic array runs at a cool 1/10 the gate power of competing devices.

Raytheon's ASIC design expertise and proprietary technology make conventional ECL arrays too hot to handle. The superior performance of the new CGA70E18 and CGA40E12: the ECL logic array family with the highest density and the lowest power requirement now available.

☐ **Superior performance:** 300 pS delay and 300 μW (typical gate) power dissipation deliver the industry's lowest speed-power product: <0.1 pJ. Toggle frequency 1.2 GHz (typical).

☐ **Highest density:**
CGA70E18 — 12540 equivalent gates
CGA40E12 — 8001 equivalent gates

☐ **Lowest power:** Industry's smallest bipolar transistors result in power dissipation that is a fraction of conventional ECL at comparable propagation delays. Typical chip power dissipation of 3W to 5W.

☐ **Et cetera:** Interface TTL, ECL (10K, 10KH, 100K), ETL. Customer access to proven, fully integrated CAD system. Commercial and military operating ranges.

Call Raytheon for access to the right ECL technology. We're not blowing any smoke, and neither should your system's performance.

Raytheon Company
Semiconductor Division
350 Ellis Street
Mountain View, CA 94039-7016
(415) 966-7716

Access to the right technology

Raytheon

CIRCLE NO 90

power splitters combiners

the world's largest selection
2KHz to 4.2GHz from $9^{95}

With over 150 models, from 2-way to 48-way, 0°, 90° and 180°, a variety of pin and connector packages, 50 and 75 ohm, covering 2KHz to 4200MHz, Mini-Circuits offers the world's largest selection of off-the-shelf power splitter/combiners. So why compromise your systems design when you can select the power splitter/combiner that closely matches your specific package and frequency band requirements at lowest cost and with immediate delivery.

And we will handle your "special" needs, such as wider bandwidth, higher isolation, intermixed connectors, etc. courteously with rapid turnaround time.

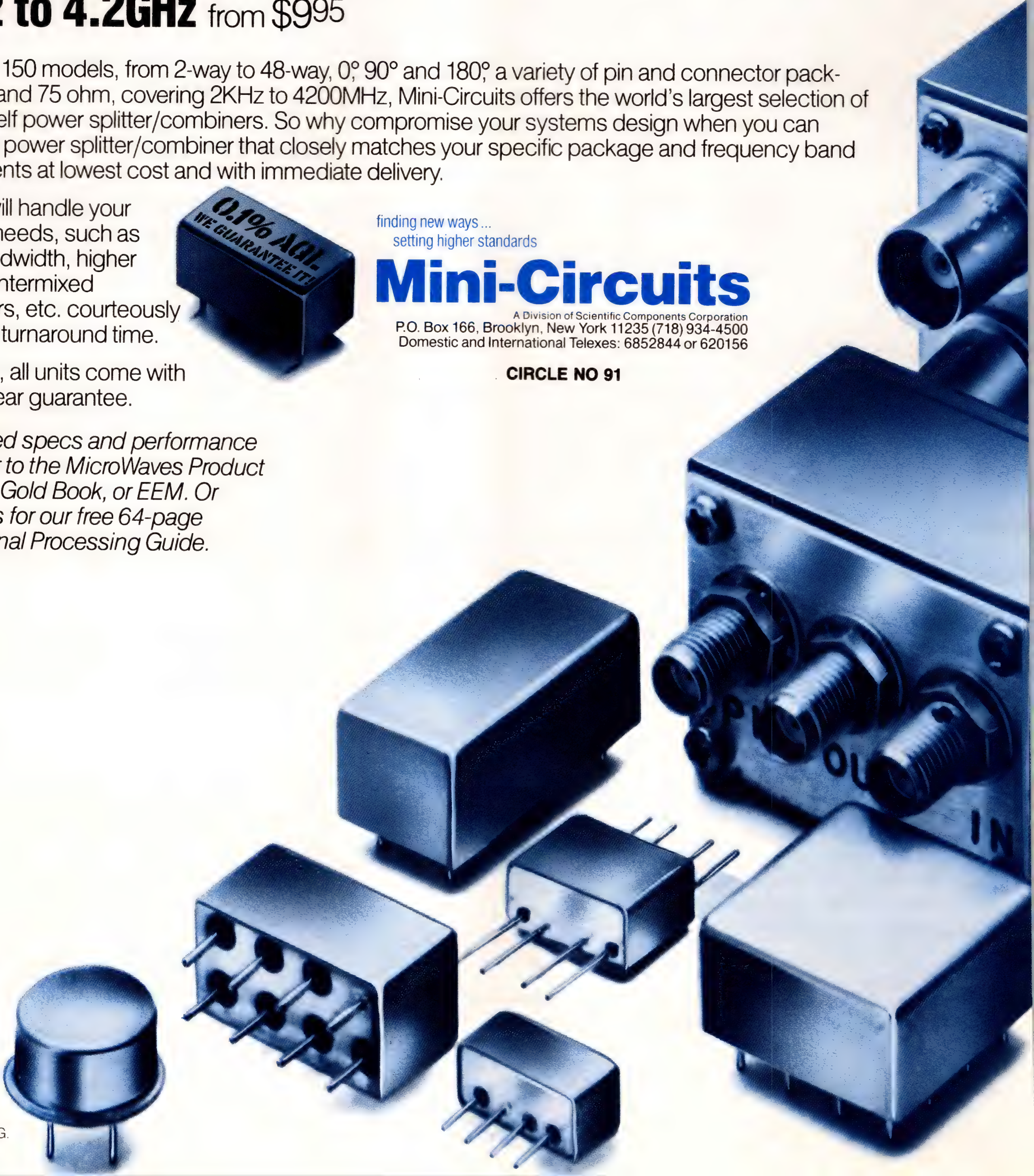
Of course, all units come with our one-year guarantee.

For detailed specs and performance data, refer to the MicroWaves Product Directory, Gold Book, or EEM. Or contact us for our free 64-page RF/IF Signal Processing Guide.

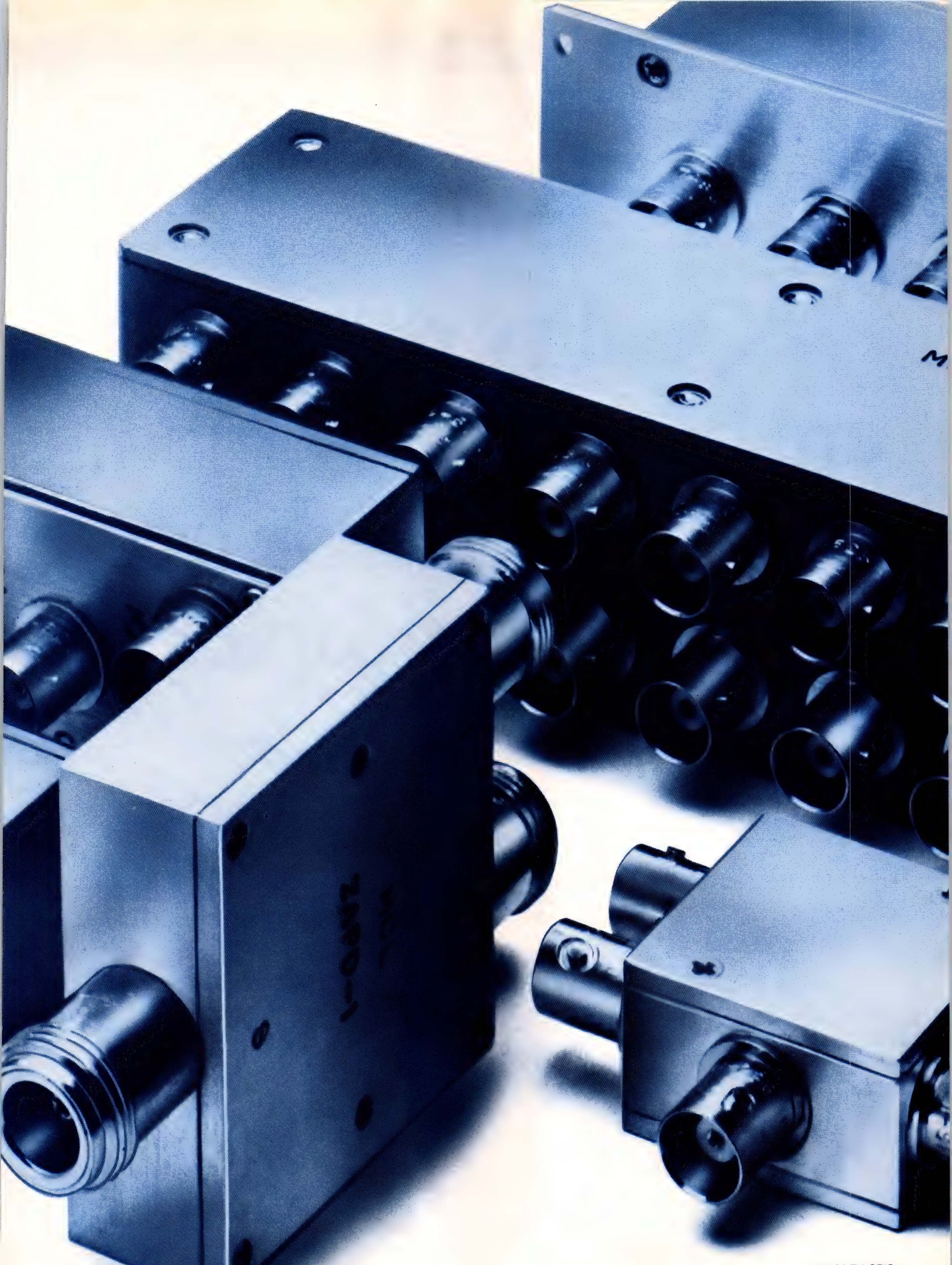
finding new ways ...
setting higher standards

Mini-Circuits
A Division of Scientific Components Corporation
P.O. Box 166, Brooklyn, New York 11235 (718) 934-4500
Domestic and International Telexes: 6852844 or 620156

CIRCLE NO 91



C107-1 REV. ORIG.



C107-2 REV. ORIG.

"Quality products are not made by robots. They're made by quality people."

Jack E. Haslup
Manufacturing Operations Manager

American electronics companies today face some serious challenges in manufacturing—the main one being how to compete successfully with our offshore rivals. That's why at Motorola we've taken several radical steps aimed at reaching new levels of quality and manufacturing efficiency.

A commitment to 6-Sigma quality levels.

Last year, Motorola began working toward a quality goal of 6 *Sigma* for all manufacturing, as part of our Statistical Process Control program. That translates into a defect rate of 3.4 parts per million, or an effective yield of 99.99966%. In short, zero defects. And remember, we're talking about *board*-level here, not components.

The move to Just-in-Time manufacturing.

To reach those quality levels, we've undergone a revolutionary change in our manufacturing culture at Motorola, using Just-in-Time techniques. JIT gives us a discipline for looking at *every* step of our manufacturing process, and eliminating waste. It has already helped us shorten our build cycle over 80%. Ultimately, we want to be able to build only those products our customers want. And ship them the same day they're ordered.

The right tools for total quality control.

At Motorola, we make what amounts to custom products, using mass manufacturing techniques. To track the 78 different products we build, we've recently installed an on-line Quality Information System that uses bar code readers to gather process and quality data. We're evolving toward a "paperless" factory that experts tell us is a showcase in the industry.

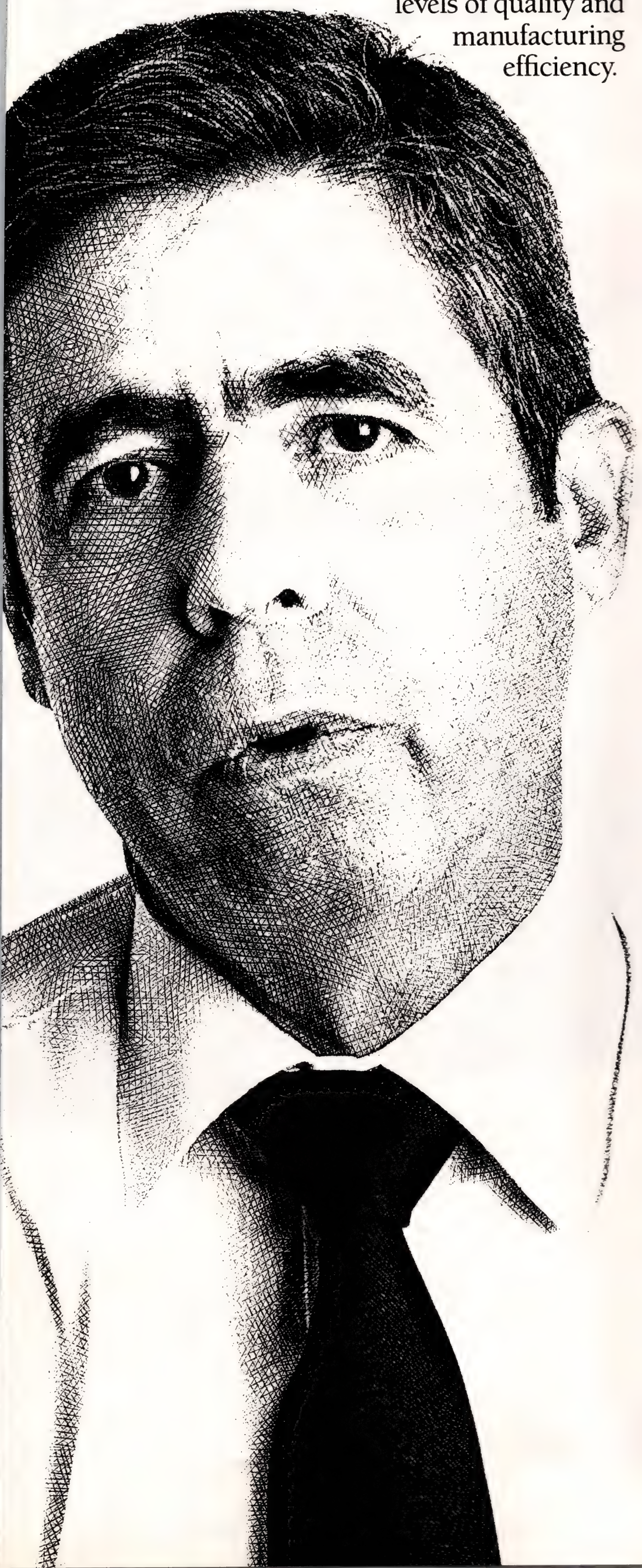
The necessity of strong manufacturing for survival.

Quality and manufacturing excellence are more than just words. They're essential in today's global competitive environment. Which is why we feel—quite frankly—that only those corporate cultures focused on quality goals like 6 Sigma will survive. In fact, any VME board or system vendor who *doesn't* have strong manufacturing isn't really in this business to stay. That's why we're always ready to *demonstrate* our capabilities. Because we don't know of anyone who has a stronger commitment to quality and manufacturing excellence than Motorola. That's what being the leader means.

MOTOROLA Microcomputer Division
Approaching our technology from your point of view.

For reprints of this series, call 1-800-556-1234, Ext. 230; in California, 1-800-441-2345, Ext. 230. Or write: Motorola Microcomputer Division, 2900 South Diablo Way, Tempe, AZ 85282.

CIRCLE NO 92



VME/PLUS™ gives view of your

Hold on to your seat. You're about to discover an entirely new level of VME performance.

Meet VME/PLUS. Our new family of VMEbus products with a host of sophisticated features that will give **VME/PLUS** your project the kind of performance you've only dreamed about.

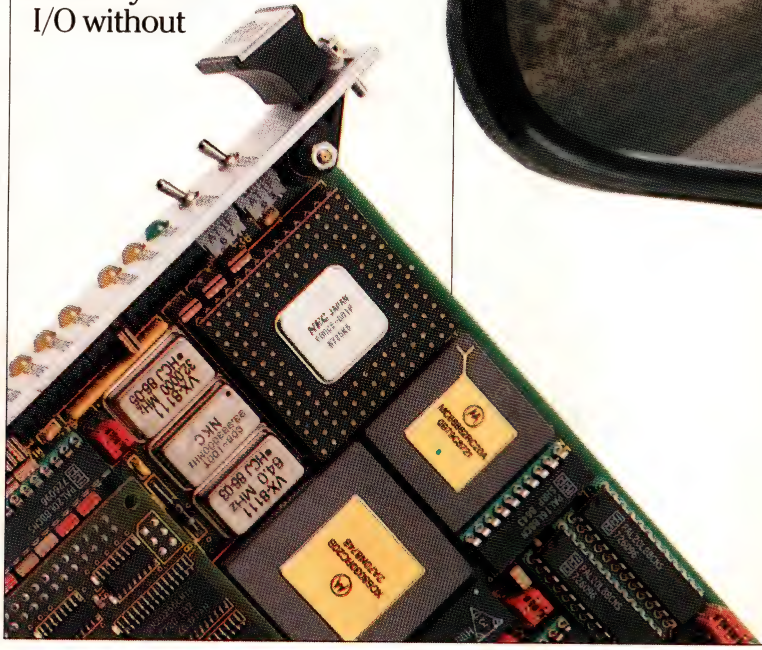
VME/PLUS gives you a choice of microprocessors, including a 68030 running at 25MHz without wait states. Complemented by 1MB of local memory. There's also a new VSB interface on P2. Which lets you add lots of local memory and I/O without increasing bus overhead. You also get two serial ports and up to 4MB of EPROM.

The result is system throughput that's way ahead of anything else in the VME world.

AVAILABLE WITH 68030

Think about the possibilities for real-time applications. For the first time, you can squeeze every ounce of performance from every processor. With no wasted overhead. And no stalls.

But that's only the beginning. The newest



you a different competition.

member of the VME/PLUS family, CPU-32, comes with

a powerful new real-time, multitasking monitor called VMEPROM. It's resident in EPROM, so there's no license required and no extra charge.

CPU-32 also includes full support for real-time operating systems and UNIX 5.3.

What this new technology means for you is unprecedented levels of speed and system throughput, exceptional reliability and – here's the best part – lower total system cost.

And if that's not enough, we also offer a full set of off-the-shelf peripheral boards and software. All VMEbus compatible. And guaranteed to cut the wait states out of your design cycle.

So if you're looking for the best way to stay ahead of your competition and your deadline, take a close look at VME/PLUS.

Call us today at 1(800)BEST VME, and ask for our new 550-page, 1988 data book. You'll get such a great view of VME performance, you'll never look back.

CPU-32 CHARACTERISTICS

PROCESSOR	68030/16.7 TO 25 MHz
CO-PROCESSOR	68882/16.7 TO 25 MHz
ZERO-WAIT-STATE SRAM	1MB
VMEPROM	REAL-TIME, MULTITASKING MONITOR
EPROM	UP TO 4MB @ 1 WAIT-STATE
SERIAL I/O	2 RS-232 CHANNELS
SECONDARY BUS SUPPORT	VSB

FORCE COMPUTERS®

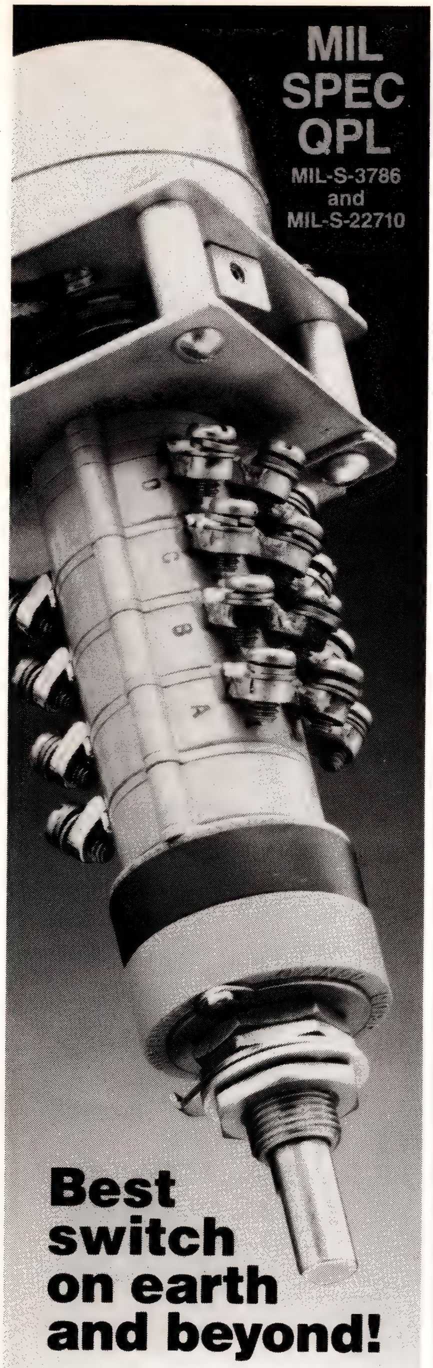
VME at its best.

FORCE COMPUTERS, INC.
3165 Winchester Blvd., Campbell, CA 95008
Telephone (408) 370-6300
Telefax (408) 374-1146

FORCE COMPUTERS, GmbH
Daimlerstrasse 9 D-8012 Ottobrunn
Telefon (089) 60091-0 Telex 524190 forc-d
Telefax (089) 6 097793

© 1988 Force Computers, Inc.
VME/PLUS is a trademark of Force Computers, Inc. UNIX 5.3 is a trademark of AT&T, Bell Laboratories.

CIRCLE NO 111



Shooting for the moon?

Our rotary switches have been there and back. And on almost every NASA project since the space program began.

We make everything from micro-miniature rotary selector switches to totally enclosed explosion-proof power selector switches, for major airframe and aerospace contractors all over the globe.

And, if we don't have what you need, we can design and custom build a switch to your exact specifications.

Even if they're out of this world.

Janco
An ESOP Corp.
P.O. Box 3038, 3111 Winona Avenue
Burbank, CA 91504 (818) 846-1800
TWX 910-498-2701 FAX (818) 842-3396

CIRCLE NO 2

SIGNALS & NOISE

IEEE will survive its current troubles

In his February 4 editorial (pg 53), Jon Titus predicted that the IEEE was facing extinction. Although I concur with Jon's observations relating to the IEEE Board of Directors' decision on approval voting, I don't feel that it spells the end for the IEEE. The IEEE has survived for 104 years and will continue to do so. Whether it has the impact it has had in the past remains to be seen. Issues such as portable pensions, reinstitution of the IRA deduction, and engineer utilization are still being worked on by committees of the IEEE. Unfortunately, all these efforts by numerous volunteers have been lost in the miasma of the Board's actions. Although I can't defend or explain away the Board's recent action, I can still recommend membership in the IEEE.

Paul J Kostek
Boeing Aerospace Co
Seattle, WA

Feerst takes prize for endurance

Bravo to Jon Titus for his editorial "The IEEE faces extinction" in the February 4 issue (pg 53). Verily he speaks the truth, but who is listening?

I've been in this business a long time, but I quit the IEEE in disgust back in 1967 for the same general reasons that Jon Titus and Irwin Feerst state. I've helped the Committee of Concerned EEs at least once, but the indifference of my fellow engineers made it seem hopeless. Irwin Feerst surely deserves the prize for patience, endurance, and faithfulness to his ideals.

Jon Titus is in a position to be a great help to the working engineer. I hope that he continues to do so.

Gene D Barber
(A working engineer)
San Diego, CA

"I HAVE AN IDEA WHY WE'VE HAD SO MUCH DOWN TIME ON OUR COMPUTERS."

Single-chip μC comes Forth

Isn't it funny how computer languages expose intolerance in people (see Robert Johnson's letter in EDN, February 18, 1988, pg 34). Personally, I believe that anyone not using Fortran on single-chip micros should be stood up against the wall . . . . Seriously, though, Steve Leibson might like to know that Micromint (Vernon, CT, (203) 871-6170) sells a Forth chip based on the Z8.

Peter Hand
PDA Designs Ltd
Portsmouth, England

YOUR TURN

EDN's Signals and Noise column provides a forum for readers to express their opinions on issues raised in the magazine's articles or on any topic that affects the engineering industry. Send your letters to the Signals and Noise Editor, 275 Washington St, Newton, MA 02158. We welcome all comments, pro or con. All letters must be signed, but we will withhold your name upon request. We reserve the right to edit letters for space and clarity.

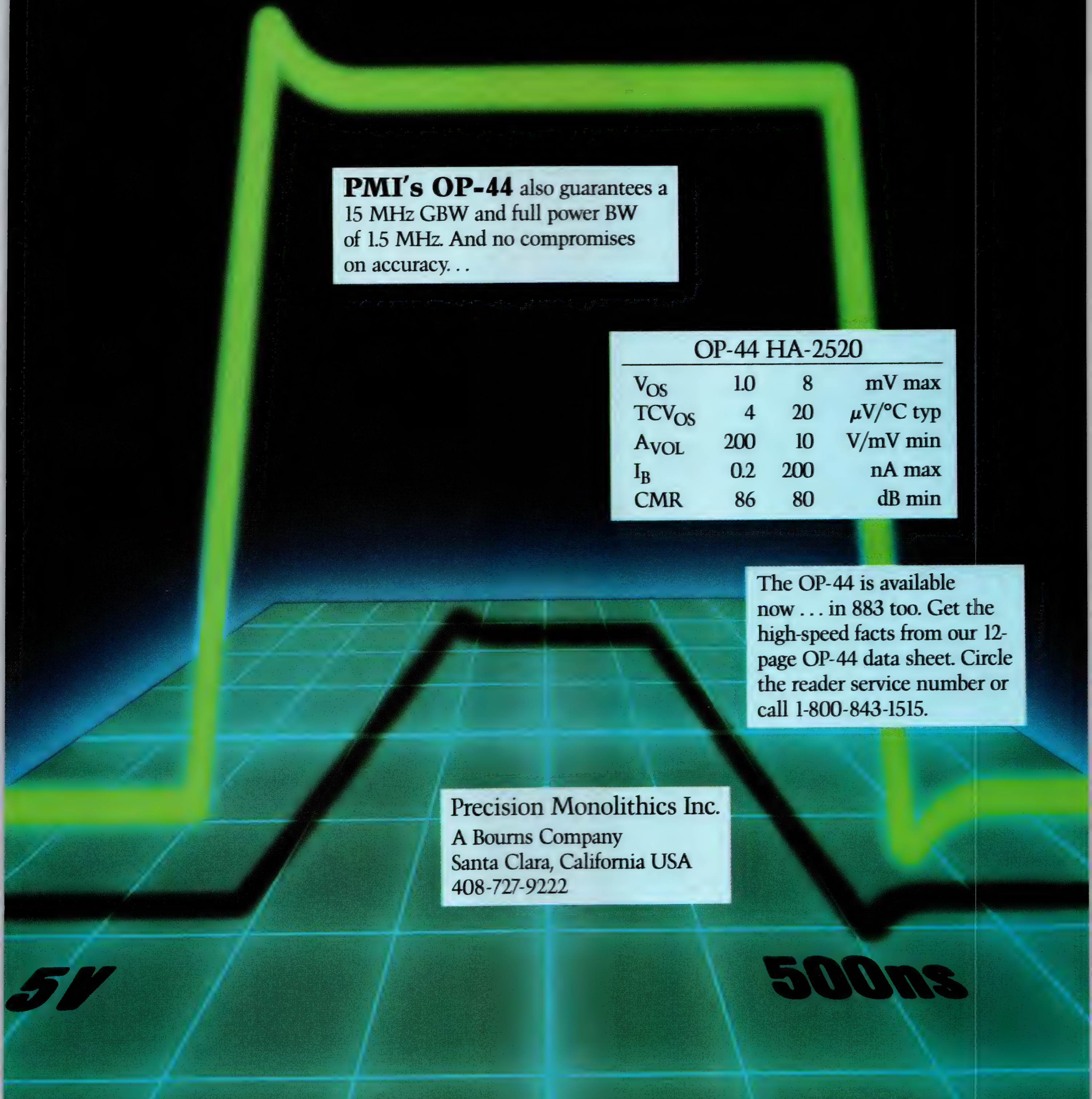
100 V/μs GUARANTEED

PMI's OP-44 also guarantees a 15 MHz GBW and full power BW of 1.5 MHz. And no compromises on accuracy. . .

	OP-44	HA-2520	
V_{OS}	1.0	8	mV max
TCV_{OS}	4	20	μV/°C typ
A_{VOL}	200	10	V/mV min
I_B	0.2	200	nA max
CMR	86	80	dB min

The OP-44 is available now . . . in 883 too. Get the high-speed facts from our 12-page OP-44 data sheet. Circle the reader service number or call 1-800-843-1515.

Precision Monolithics Inc.
A Bourns Company
Santa Clara, California USA
408-727-9222



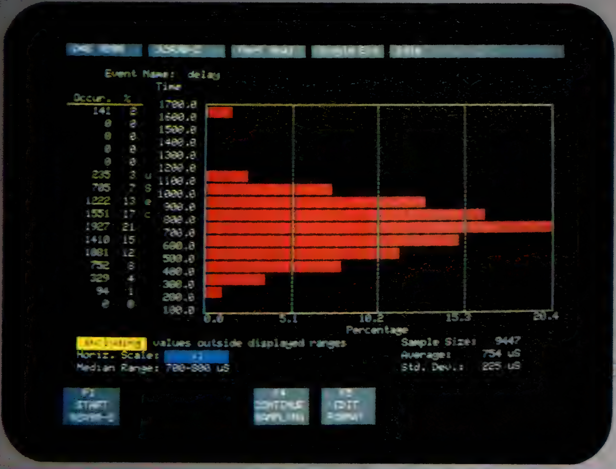
FRANCE: (1) 40 03 35 93; **GERMANY:** (0711) 22 93-0; **BENELUX:** (070) 87 54 04; **SWITZERLAND:** (042) 33 33 33; **UNITED KINGDOM:** (0276) 692 392; **HONG KONG:** 0-4992688; **JAPAN:** (03) 260-1411; **ARGENTINA:** (46) 5776/0628/0864/2214; **AUSTRALIA:** (02) 439-4655; **AUSTRIA:** (0222) 43 26 39; **DENMARK:** (02) 98 63 33; **FINLAND:** (90) 565 38 77; **INDIA:** 222 999; **ISRAEL:** (23) 924 09 25; **ITALY:** (02) 569 57 46; **KOREA:** (02) 244-7492; **NORWAY:** (06) 83 20 00; **SINGAPORE:** 747-6188; **SPAIN:** (91) 405 42 13; **SWEDEN:** (08) 768 05 60; **TAIWAN:** (02) 752 2200; **YUGOSLAVIA:** (041) 42 37 46

CIRCLE NO 93

PMI

The precision solution.

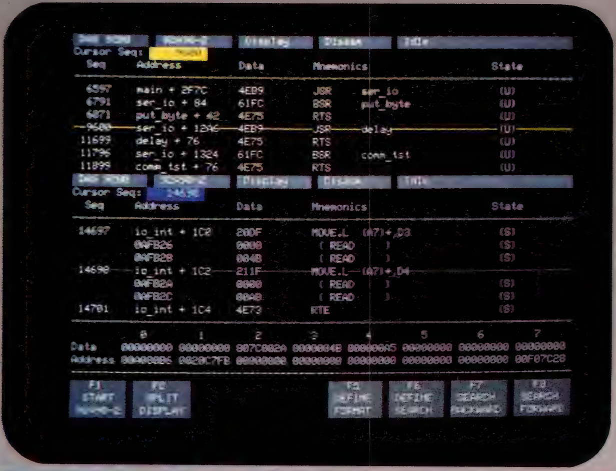
DAS9200 DIGITAL ANALYSIS: NOW TEK MAKES THE IMPOSSIBLE LOOK EASY.



```
Event Name:  delay
                 Time
Occur.   %
  141    2     1700.0
    0    0     1600.0
    0    0     1500.0
    0    0     1400.0
    0    0     1300.0
    0    0     1200.0
  235    3  u  1100.0
  705    7  S  1000.0
 1222   13  e   900.0
 1551   17  c   800.0
 1927   21      700.0
 1410   15      600.0
 1081   12      500.0
  752    8      400.0
  329    4      300.0
   94    1      200.0
    0    0      100.0
```

```
values outside displayed ranges          Sample Size:    9447
Horiz. Scale:                            Average:      754 uS
Median Range: 700-800 uS                 Std. Dev.:    225 uS
```

Software Performance Analysis, like this distribution of a subroutine's execution times, helps you easily understand the activity of your code.



```
Cursor Seq:
 Seq     Address          Data     Mnemonics             State

  6597   main + 2F7C      4EB9     JSR     ser_io        (U)
  6791   ser_io + 84      61FC     BSR     put_byte      (U)
  6871   put_byte + 42    4E75     RTS                   (U)
  9680   ser_io + 12A6    4EB9     JSR     delay         (U)
 11699   delay + 76       4E75     RTS                   (U)
 11796   ser_io + 1324    61FC     BSR     comm_tst      (U)
 11899   comm_tst + 76    4E75     RTS                   (U)
Cursor Seq:
 Seq     Address          Data     Mnemonics             State

 14697   io_int + 1C0     200F     MOVE.L  (A7)+,D3      (S)
         0AFB26           0000      ( READ      )        (S)
         0AFB28           004B      ( READ      )        (S)
 14698   io_int + 1C2     211F     MOVE.L  (A7)+,D4
         0AFB2A           0000      ( READ      )        (S)
         0AFB2C           00AB      ( READ      )        (S)
 14701   io_int + 1C4     4E73     RTE                   (S)

            0        1        2        3        4        5        6        7
Data     00000000 00000000 007C002A 0000004B 000000A5 00000000 00000000 00000000
Address  00000006 0020C7FB 00000000 00000000 00000000 00000000 00000000 00F07C28
```

Step backwards through acquired data, including subroutines, stack and register models, using time-correlated split-screen displays to pinpoint problems.

In every dimension—speed, channel width, memory depth, trigger capability, modularity and ease of use—the DAS9200 dwarfs what's been possible before.

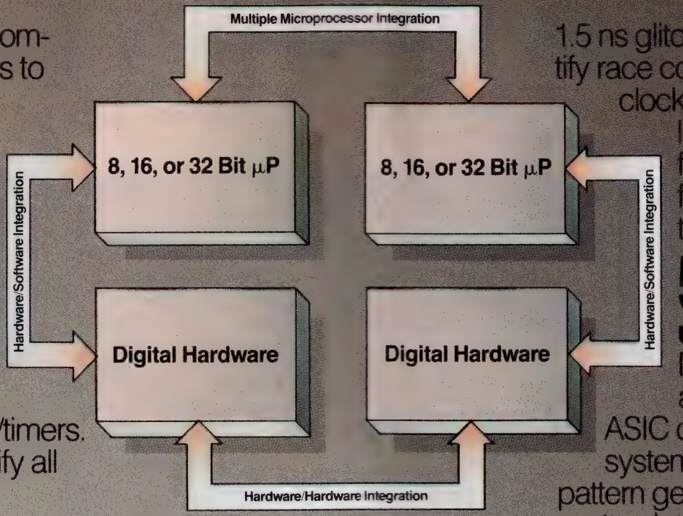
The DAS9200 features a tightly coupled, high-speed architecture in which multiple card modules can act as a single unit. Large color-coded displays, pop-up menus, performance analysis graphs,

Copyright © 1987, Tektronix, Inc. All rights reserved. LAA-405-1

multi-tasking and more combine to take logic analysis to levels like these:

1 State-driven triggering at 200 MHz. You can use up to 384 channels of sync and async data acquisition. You can assurance-test high-speed logic at full speed, using 4-level state tracking and high-speed counter/timers. You can monitor and verify all timing measurements in a circuit.

2 Symbolic, real-time software debugging. Register deduction and stack simulation let you pinpoint problems like stack overflow or incorrectly restored pointers—without breakpoints or manual notation.

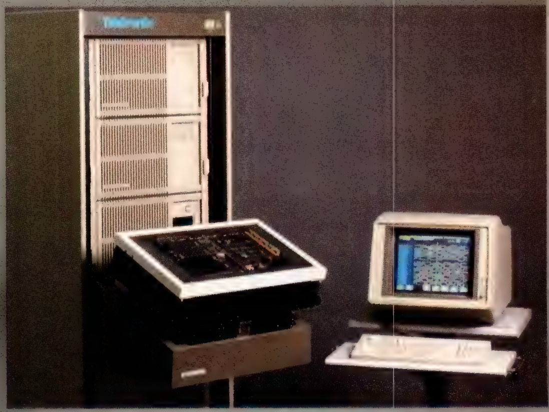

Multiple Microprocessor Integration
8, 16, or 32 Bit μP
8, 16, or 32 Bit μP
Hardware/Software Integration
Hardware/Software Integration
Digital Hardware
Digital Hardware
Hardware/Hardware Integration

3 Simultaneous integration of up to six microprocessors. Use the dual timebases and real-time handshaking between system modules to set up split-screens displays that scroll in precise time alignment.

4 160 channels of acquisition at 2 GHz. Use up to 500 ps sample interval and 1.5 ns glitch detection to identify race conditions, spurious clocks and setup/hold violations in any logic family. System probes feature input capacitance of <1 pf.

5 Easy ASIC verification at up to 50 MHz. The DAS9200 is available as a low-cost turnkey ASIC device verification system. Featuring 50 MHz pattern generation, 8K bit vector depth, and 1 ns edge placement, it offers the power, precision and simplicity to be an attractive alternative to centralized systems.

6 Stop wishing for the impossible in digital analysis: Compare your wish list against the complete list of DAS9200 capabilities. Contact your Tek sales engineer, or call toll-free for more information. **Call 1-800-245-2036.** In Oregon, 231-1220.



Available in desktop and rack-mount versions, the DAS9200 mainframe can be augmented with up to three expansion mainframes for a total of 28 card slots.

Tektronix®
COMMITTED TO EXCELLENCE

Circle 106 for Literature

Circle 107 for Sales Contact

Expand your

design vision.

Enhance your design at any stage with RCA CMOS 6805 micros and SPI peripherals.

Your challenge is to increase system performance and capability while reducing board size.

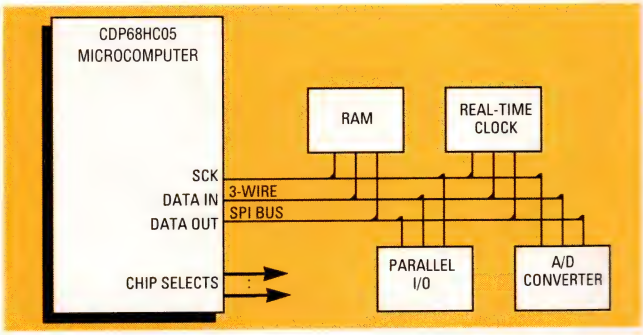
Not an easy job. But certainly easier when you use our 6805 and 68HC05 micros and serial peripheral interface devices.

Extend your micro's power.

Many microcomputers rely on parallel I/O ports to communicate with peripheral devices. An inefficient method at best.

That all changes with the serial peripheral interface incorporated into our 68HC05 microcomputers.

This three-wire (plus device select) synchronous, full-duplex, serial communication system contains separate lines for input and output data, serial clock and device select. You don't have to sacrifice I/O ports to communicate off-chip: our 68HC05 micros can communicate with our own serial peripherals, the serial peripherals of other manufacturers, and even with other microcomputers via only three port lines.



True design versatility.

The real beauty of the SPI is that it eliminates limitations imposed by microcomputers.

For example, you can easily extend the amount of I/O or memory with SPI RAMs, I/O chips or shift registers. And the modular SPI bus gives you the ability to expand without losing lots of PC-board space. Reduced package sizes and minimized interconnect wiring lead to reduced board size.

And since you don't need complex software to operate the bus, you save ROM space.

Right now, we can offer you a versatile family of peripheral devices, including 128-byte and 256-byte static RAMs, a real-time clock with RAM, an 8-bit programmable I/O port, and a 10-bit 8-channel A/D converter. And more parts are coming soon, including a digital pulse-width modulator and a serial bus interface chip for networking microcomputers. These serial peripherals are also compatible with other microcomputer types.

Powerful family of micros.

We can provide 6805 microprocessors for external memory address, but the heart of our SPI system is the 6805 Series high-speed CMOS microcomputers:

68HC05 Microcomputers

Features	68HC05C4	68HC05C8	68HC05D2	68HC05D2A
Pins	40	40	40	28
On-Chip RAM (bytes)	176	176	96	96
On-Chip User ROM (bytes)	4160	7744	2176	2176
Bidirectional I/O Lines	24	24	28	16
Unidirectional I/O Lines	7 inputs	7 inputs	3 inputs	3 inputs
Timer size (bits)	16	16	16	16
Prescaler size (bits)	*	*	*	*
External timer oscillator	no	no	yes	yes
Serial peripheral interface	yes	yes	yes	no
Serial communications interface	yes	yes	no	no

*prescaler fixed as ÷4

Easy to prototype, too.

If you need another reason to choose our 6805 family, here it is: they're so easy to prototype with our Piggyback! We have the 68EM05C4 and 68EM05D2 Emulators, custom 40-pin packages that contain the C4/C8 or D2 micros with a Piggyback EPROM socket.

When installed with a 27C64 EPROM, these devices together become functionally identical to a CDP68HC05C4, CDP68HC05C8 or CDP68HC05D2.

Two final points: we'll give you fast turnaround, and a wide variety of packages.

For more information, call toll-free 800-443-7364, extension 22. Or contact your local GE Solid State sales office or distributor.

In Europe, call: Brussels, (02) 246-21-11; Paris, (1) 39-46-57-99; London, (276) 68-59-11; Milano, (2) 82-291; Munich, (089) 63813-0; Stockholm, (08) 793-9500.

*

GE Solid State

GE/RCA/Intersil Semiconductors
Three great brands. One leading-edge company.

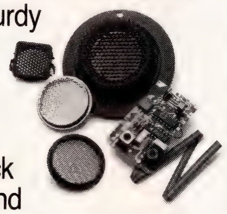
*Trademark of General Electric Company, U.S.A., not connected with the English Company of a similar name.

Polaroid's Ultrasonic Ranging System opens the door to new technology.

It can be found in "non-touch" screen computer monitors, AGV's, industrial robotics, electronic games, tape measures, aids for the disabled, loading docks, collision avoidance systems for cars, trucks and pleasure vehicles. And, yes, it even opens doors.

The Polaroid Ultrasonic Ranging System is an accurate, highly sensitive way to detect and measure the presence and distance of objects from 10.8 inches to 35 feet. What's more, accuracy, sensitivity and range can all be improved with circuit modifications.

Three of a kind. Polaroid offers three ultrasonic transducers for a wide variety of applications. You can choose the original instrument-grade transducer, proven in millions of SX-70 Sonar Autofocus cameras. Or our Environmental Transducer, available in a sturdy housing to withstand exposure to rain, heat, cold, salt spray, chemicals, shock and vibration. And now you can select our newest, smallest transducer, developed for Polaroid Spectra, the camera of the future. All use reliable, accurate and sensitive electrostatic transducer technology. All are backed by Polaroid.



Visit us at Booth #s 472, 474, 476 at ELECTRO '88

Get a $2 Million Head Start. Polaroid spent over $2 million developing the Ultrasonic Ranging System. But now you can get this technology in our Designer's Kit for only $165*. To order your Designer's Kit, please send a check or money order for $165 for each kit, plus all applicable state and local taxes, to: Polaroid Corporation, Ultrasonic Components Group, 119 Windsor Street, Cambridge, MA 02139. Questions? Call Polaroid's Applications Engineers at 617-577-4681.

______ Please send me ______ Designer's Kit(s).
______ Please send more information.

Name ________________
Title ________________
Company ________________
Address ________________
City ________ State ______ Zip ______

Polaroid

*Pricing subject to change

EDN 042888

"Polaroid", "SX-70"® "Spectra" ™

CIRCLE NO 3

CALENDAR

Pittsburgh Conference on Modeling and Simulation, Pittsburgh, PA. William Vogt or Marlin Mickle, 348 Benedum Engineering Hall, University of Pittsburgh, Pittsburgh, PA 15261. May 5 to 6.

Worst-Case Circuit Analysis (seminar), Washington, DC. Design and Evaluation, 1000 White Horse Rd, Suite 304, Voorhees, NJ 08043. (609) 770-0800. May 9 to 11.

Electro/88, Boston, MA. Electronic Conventions Management, 8110 Airport Blvd, Los Angeles, CA 90045. (800) 421-6816; in CA, (213) 772-2965. May 10 to 12.

EMC Expo, Washington, DC. Karen Smith, EMC Expo, Box D, Gainesville, VA 22065. (703) 347-0030. May 10 to 12.

Analog Applications (seminar), Chicago, IL. Precision Monolithics Inc. (800) 843-1515. May 13.

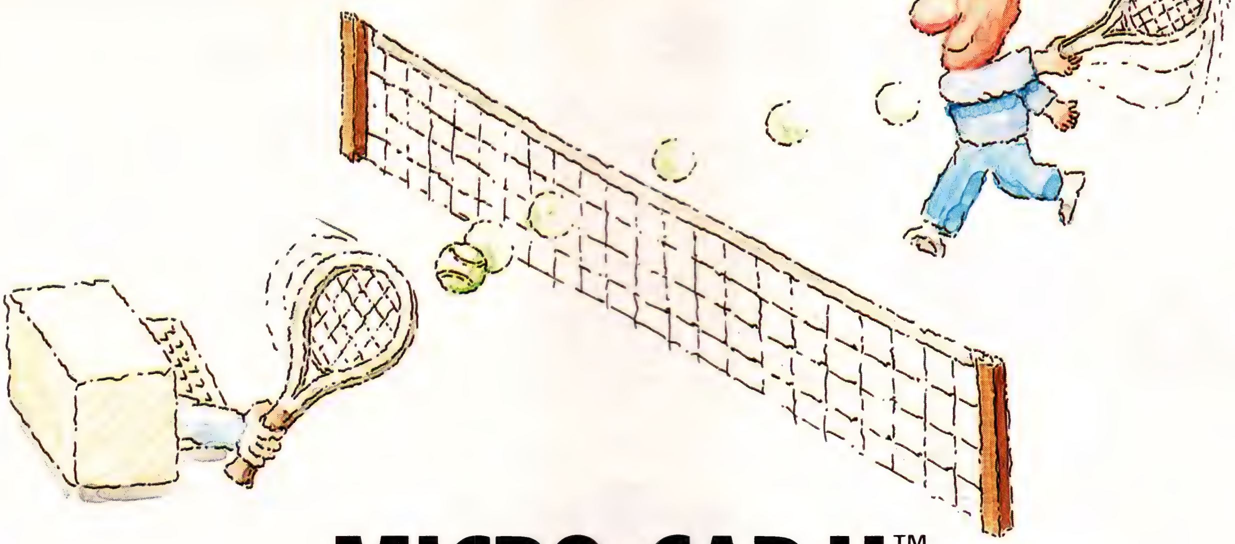
DOD-STD-2167A and DOD-STD-2168—Defense System Software Development (seminar), Washington, DC. David Maibor Associates, Box 846, Needham, MA 02194. (617) 449-6554. May 16 to 17.

IEEE Custom Integrated Circuits Conference, Rochester, NY. Roberta Kaspar, 20 Ledgewood Dr, Rochester, NY 14615. (716) 865-7164. May 16 to 19.

Modern Electronic Packaging (seminar), Minneapolis, MN. Technology Seminars, Box 487, Lutherville, MD 21093. (301) 269-4102. May 17 to 19.

C Programming: Hands-on Workshop (short course) Palo Alto, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. May 17 to 20.

Troubleshooting Microprocessor-Based Equipment and Digital De-

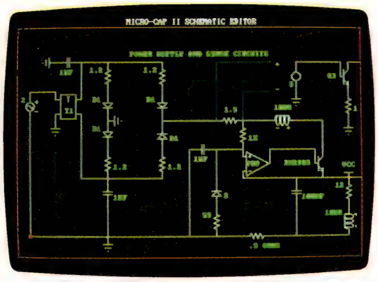


MICRO-CAP II.™

The CAE tool with fully interactive analog simulation for your PC.

Spectrum Software's MICRO-CAP II® is fast, powerful, and feature rich. This fully interactive, advanced electronic circuit analysis program helps engineers speed through analog problems right at their own PCs.

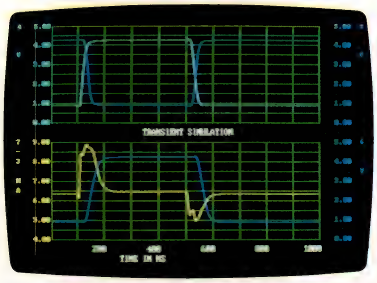
MICRO-CAP II, which is based on our original MICRO-CAP software, is a field-proven, second-generation program. But it's dramatically improved.


MICRO-CAP II SCHEMATIC EDITOR
POWER SUPPLY AND SENSE CIRCUITS

Schematic Editor

MICRO-CAP II has faster analysis routines. Better resolution and color. Larger libraries. All add up to a powerful, cost-effective CAE tool for your PC.

The program has a sophisticated integrated schematic editor with a pan capability. Just sketch and analyze. You can step component values, and run worst-case scenarios—all interactively. And a 500-type* library of standard parts is at your fingertips for added flexiblity.



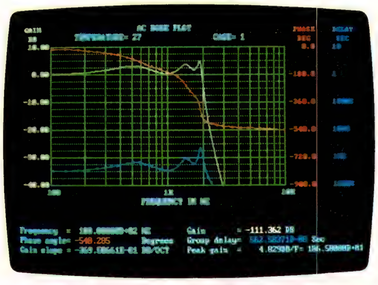
Transient Analysis

MICRO-CAP II is available for IBM® PCs and Macintosh.™ The IBM version is CGA, EGA, and Hercules® compatible and costs only $895 complete. An evaluation version is available for $100. Call or write today for our free brochure and demo disk. We'd like to tell you more about analog solutions in the fast lane.

- Integrated schematic editor
- Fast analysis routines
- High-resolution graphic output
- Standard parts library of 500* types

*IBM versions only.

- Transient, AC, DC, and FFT routines
- Op-amp and switch models
- Spec-sheet-to model converter*
- Printer and plotter* hard copy



AC Analysis

spectrum

1021 S. Wolfe Road, Dept. E
Sunnyvale, CA 94087
(408) 738-4387

MICRO-CAP II is a registered trademark of Spectrum Software.

Macintosh is a trademark of McIntosh Laboratory, Inc. and is being used with express permission of its owner.

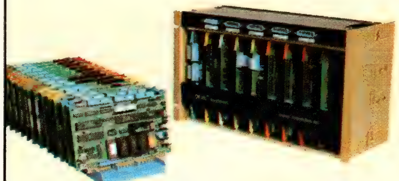
Hercules is a registered trademark of Hercules Computer Technology

IBM is a registered trademark of International Business Machines, Inc.

CIRCLE NO 115

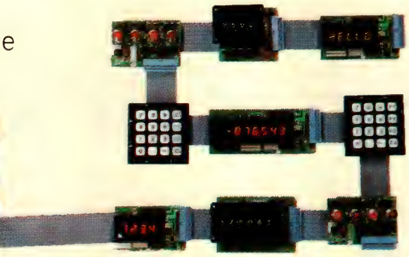
Build Custom Industrial Controllers In Just A Few Days

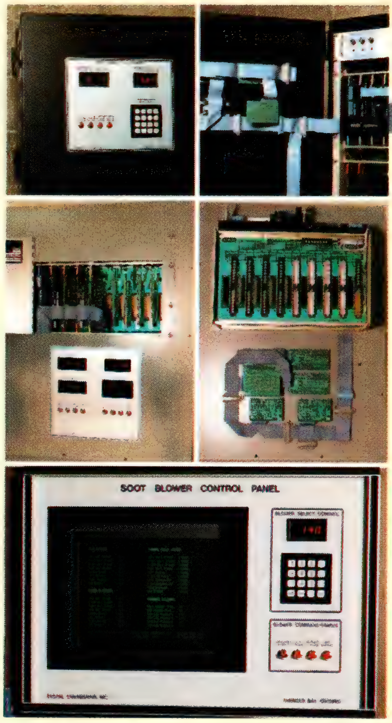
*The **DEIBI**™ system hardware modules and industrial BASIC language provides quick and easy solutions for measurement and control applications.*



Features:

☐ Analog and Digital Signal Handling
☐ Control Panel Operations
☐ Real Time Operations
☐ Time Scheduled Operations
☐ Full Function Math
☐ Direct Floating Point with I/O
☐ Data Communications
☐ Excellent Program Readability
☐ Formattable Reporting
☐ No Binary or Machine Language
☐ OEM Applications





Typical DEIBI systems are shown on the left. An RTD motor temperature monitor/alarm system, a peak load controller with custom mounting and a soot blower control panel with VDT readout.

Send for our full color brochure and product catalogue.

DIGITAL ENGINEERING INC.

1186 Russell Street
Thunder Bay, Ontario
Canada P7B 5N2
Tel: (807) 623-3700
Fax: (807) 623-6398

CIRCLE NO 4

DID YOU KNOW?

EDN serves
electronic engineers and
engineering managers in more than
100 countries worldwide.

EDN

CALENDAR

vices (seminar), Denver, CO. Micro Systems Institute, 73 Institute Rd, Garnett, KS 66032. (800) 247-5239; in KS, (913) 898-4695. May 17 to 20.

California Computer and Graphics Show, Palo Alto, CA. Norm De Nardi Enterprises, 289 S San Antonio Rd, #204, Los Altos, CA 94022. May 19.

DOD-STD-2167A and DOD-STD-2168—Defense System Software Development (seminar), Boston, MA. David Maibor Associates, Box 846, Needham, MA 02194. (617) 449-6554. May 19 to 20.

DOD-STD-2167A and DOD-STD-2168—Defense System Software Development (seminar), Orlando, FL. David Maibor Associates, Box 846, Needham, MA 02194. (617) 449-6554. May 23 to 24.

31st Annual Instrument Society of America Power Symposium, St Petersburg, FL. Bill Blazier, Illinois Power Co, 500 S 27th St, Decatur, IL 62525. (217) 424-6622. May 23 to 25.

Society for Information Display International Symposium, Anaheim, CA. Palisades Institute for Research Services, 201 Varick St, Rm 1140, New York, NY 10014. (212) 620-3388. May 23 to 27.

C Programming: Hands-on Workshop (short course), Washington, DC. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. May 24 to 27.

Troubleshooting Microprocessor-Based Equipment and Digital Devices (seminar), Kansas City, MO. Micro Systems Institute, 73 Institute Rd, Garnett, KS 66032. (800) 247-5239; in KS, (913) 898-4695. May 24 to 27.

Q.

How much does
a twenty-cent coupler
really cost?

A. What you're buying with a 20¢ coupler isn't just a part. It's an insurance policy. You don't think about it until it fails, then you're out a lot more than 20¢. That's why as General Instrument we reduced our defect rate to fewer than 50 ppm. And now, as Quality Technologies we maintain that standard on our complete line of optocouplers. To provide smoother production and better performance. So, if the question is where to find quality optocouplers, the answer is Quality Technologies. (800) LED-OPTO.

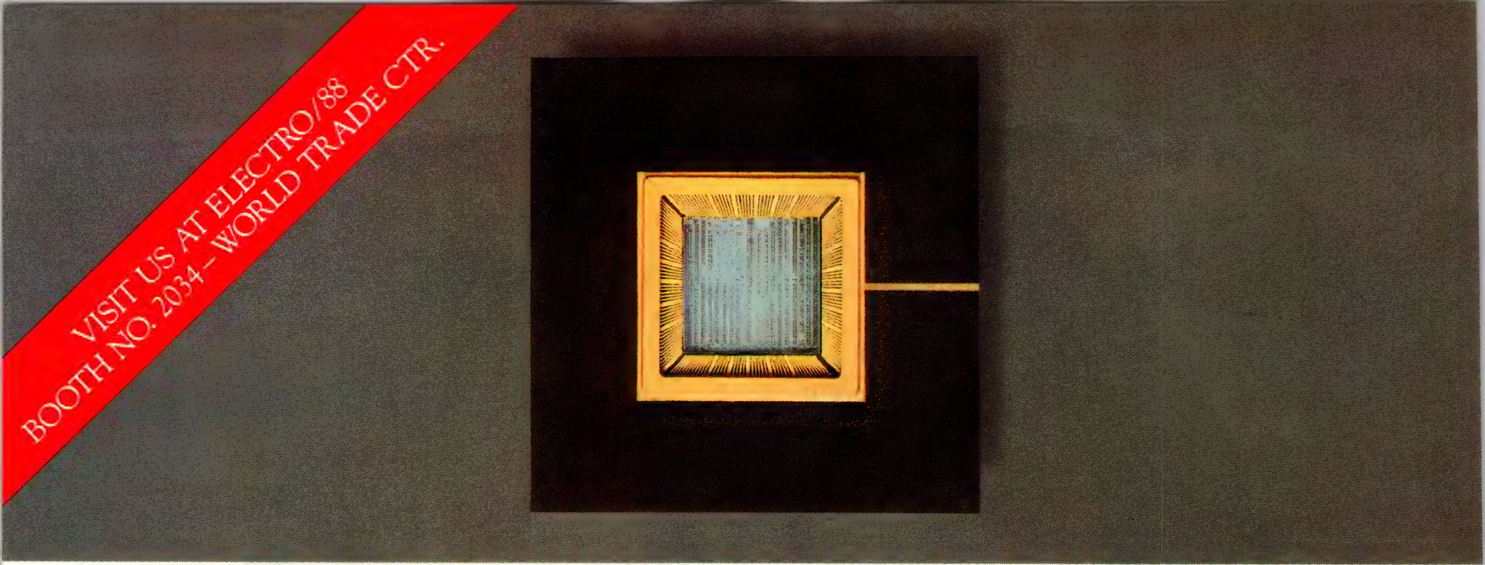
QUALITY
TECHNOLOGIES

Quality is always the answer.

SEE US AT ELECTRO, BOOTH #3018

© 1988 Quality Technologies Corporation

CIRCLE NO 121



50,000 Gates At 0.7 Nanoseconds.

Toshiba's process technology has made us the world's leading supplier of CMOS devices. From this experience comes the capability to build a 50,000 gate ASIC.

And from Toshiba's manufacturing capabilities comes the volume production to meet your smallest or greatest needs.

These new Toshiba "Sea of Gates" Compacted Arrays™ provide high packing density for more effective silicon utilization and ultra-high speed. And they are available in 5 base arrays with usable gates from 15,000 to 50,000.

TOSHIBA. THE POWER IN GATE ARRAYS.

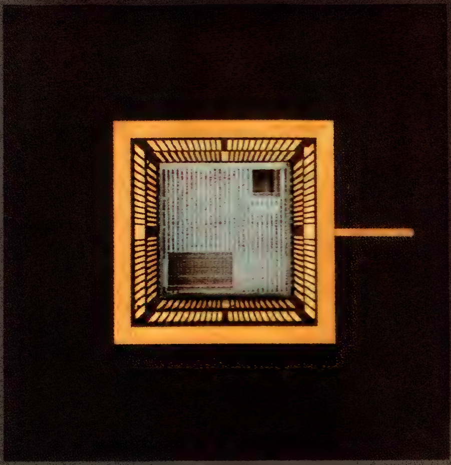
	3 MICRON CHANNELLED ARRAY	2 MICRON CHANNELLED ARRAY	1.5 MICRON CHANNELLED ARRAY	SEA OF GATES COMPACTED ARRAY™
SERIES	TC15G	TC17G	TC19G	TC110G
GATES	880 to 6,000	540 to 10,000	3,200 to 10,000	2,100 to 50,000
DESIGN RULE	3μm	2μm	1.5μm	1.5μm
GATE SPEED	2.5ns	1.5ns	1.0ns	0.7ns
PART NO's	6	9	5	5
AVAILABILITY	NOW	NOW	NOW	NOW

All Si-Gate CMOS double layer metal. Compacted Array is a trademark of LSI Logic Corporation.

This new family is compatible with Toshiba's existing channelled array families, using compatible macrocell libraries and CAD software.

If you are working on advanced products – or working to advance existing products, talk to Toshiba at one of our conveniently located Design Centers. We're leading the way. Toshiba. The power in gate arrays.

AREA SALES OFFICES: CENTRAL AREA, Toshiba America, Inc., (312) 945-1500; **EASTERN AREA,** Toshiba America, Inc., (617) 272-4352; **NORTHWESTERN AREA,** Toshiba America, Inc., (408) 737-9844; **SOUTHWESTERN REGION,** Toshiba America, Inc., (714) 259-0368; **SOUTH CENTRAL REGION,** Toshiba America, Inc., (214) 480-0470; **SOUTHEASTERN REGION,** Toshiba America, Inc., (404) 368-0203; **MAJOR ACCOUNT OFFICE,** Fishkill, New York, Toshiba America, Inc., (914) 896-6500; **BOCA RATON, FLORIDA,** Toshiba America, Inc., (305) 394-3004. **REPRESENTATIVE OFFICES: ALABAMA,** Montgomery Marketing, Inc., (205) 830-0498; **ARIZONA,** Summit Sales, (602) 998-4850; **ARKANSAS,** MIL-REP Associates, (512) 346-6331; **CALIFORNIA** (Northern) Elrepco, Inc., (415) 962-0660; **CALIFORNIA** (L.A. & Orange County) Bager Electronics, Inc., (818) 712-0011, (714) 957-3367, (San Diego County) Eagle Technical Sales, (619) 743-6550; **COLORADO,** Straube Associates Mountain States, Inc., (303) 426-0890; **CONNECTICUT,** Datcom, Inc., (203) 288-7005; **FLORIDA,** Sales Engineering Concepts, (305) 426-4601, (305) 682-4800; **GEORGIA,** Montgomery Marketing, Inc., (404) 447-6124; **IDAHO,** Components West, (509) 922-2412; **ILLINOIS,** Carlson Electronic Sales, (312) 956-8240, R.W. Kunz, (314) 966-4977; **INDIANA,** Leslie M. DeVoe Company, (317) 842-3245; **IOWA,** C.H. Horn, (319) 393-8703; **KANSAS,** D.L.E. Electronics, (316) 744-1229; **KENTUCKY,** Leslie M. DeVoe Company, (317) 842-3245; **LOUISIANA,** MIL-REP Associates, (713) 444-2557; **MAINE,** Datcom, Inc., (617) 891-4600; **MASSACHUSETTS,** Datcom, Inc., (617) 891-4600; **MICHIGAN,** Action Components Sales, (313) 349-3940; **MINNESOTA,** Electric Component Sales, (612) 933-2594;



RAM & ROM Memory In CMOS ASICs.

Now add custom-built memory to your standard cell designs. Add ROM in various word and bit combinations up to 16 kbits. Add RAM in word and bit configurations up to 4 kbits.

Based on Toshiba's proprietary 2-micron, double-metal CMOS process, this new series of devices is compatible with existing and future Toshiba standard cell and gate array families.

These advanced devices integrate up to 10,000 gate equivalents with typical speeds of 1.5 nanoseconds for a loaded 2-input/2-output NAND gate.

Look to Toshiba for the newest advances in custom LSIs and for the manufacturing strength that means unmatched production capability.

For complete details, call your Regional Sales Manager at one of Toshiba's Regional Sales Offices:
NORTHWESTERN: San Jose, CA (408) 244-4070.
SOUTHWESTERN: Newport Beach, CA (714) 752-0373.
NORTH CENTRAL: Chicago, IL (312) 945-1500.
SOUTH CENTRAL: Dallas, TX (214) 480-0470.
NORTHEASTERN: Burlington, MA (617) 272-4352.
SOUTHEASTERN: Atlanta, GA (404) 493-4401.

TOSHIBA.
THE POWER IN STANDARD CELLS.

SERIES	TC21SC	TC22SC
GATES	MAX. 10K	MAX. 10K
CAD	VLSI CAD-I	VLSI CAD-IA
DESIGN RULE	2.0 µm	2.0 µm
SPEED	1.5 ns	1.5 ns
MACRO FUNCTIONS	TC17G Gate Array MACRO Cell	TC21SC MACROs, plus: RAM 4K ROM 16K Functional MACROs 74 Series
AVAILABILITY	NOW	NOW

All Si-Gate CMOS double layer metal.

TOSHIBA AMERICA, INC.

MISSISSIPPI, Montgomery Marketing, Inc., (205) 830-0498; **MISSOURI,** D.L.E. Electronics, (316) 744-1229, R.W. Kunz, (314) 966-4977; **MONTANA,** Components West, (206) 885-5880; **NEVADA,** Elrepco, Inc., (415) 962-0660; **NEBRASKA,** D.L.E. Electronics, (316) 744-1229; **NEW ENGLAND,** Datcom, Inc., (617) 891-4600; **NEW HAMPSHIRE,** Datcom, Inc., (617) 891-4600; **NEW JERSEY,** Nexus-Technology, (201) 947-0151; **NEW MEXICO,** Summit Sales, (602) 998-4850; **NEW YORK,** Nexus Technology, (201) 947-0151; Pi-tronics, (315) 455-7346; **NORTH CAROLINA/SOUTH CAROLINA,** Montgomery Marketing, Inc., (919) 467-6319; **NORTH DAKOTA/SOUTH DAKOTA,** Electric Component Sales, (612) 933-2594; **OHIO,** Steffen & Associates, (216) 461-8333; (419) 884-2313, (513) 293-3145; **OKLAHOMA,** MIL-REP Associates, (214) 644-6731; **OREGON,** Components West, (503) 684-1671; **PENNSYLVANIA,** Nexus Technology, (215) 675-9600, Steffen & Associates, (412) 276-7366; **RHODE ISLAND,** Datcom, Inc., (617) 891-4600; **TENNESSEE,** Montgomery Marketing, Inc., (205) 830-0498; **TEXAS,** MIL-REP Associates, (512) 346-6331, (713) 444-2557, (214) 644-6731; **UTAH,** Straube Associates Mountain States, Inc., (801) 263-2640; **VERMONT,** Datcom, Inc., (617) 891-4600; **WEST VIRGINIA,** Steffen & Associates, (419) 884-2313; **WASHINGTON,** Components West, (206) 885-5880, (509) 922-2412; **WISCONSIN,** Carlson Electronics, (414) 476-2790, Electric Component Sales, (612) 933-2594; **WYOMING,** Straube Associates Mountain States, Inc., (303) 426-0890; **CANADA, BRITISH COLUMBIA,** Components West, (206) 885-5880; **ONTARIO,** Electro Source, Inc., (416) 675-4490, (613) 726-1452.

CIRCLE NO 114

© 1986 Toshiba America, Inc.

© 1988 VCH International

Why you'll find us to be the beacon of miniature lamps.

It's really quite simple: others offer you a product, we offer a company. And a commitment.

It's also simple to prove. Next time the rep who fills your miniature lamp needs is in, ask him for performance data, too. Or a competitive analysis, or quarterly product audit and reliability test data. Or a legacy of excellence like we began with Chicago Miniature.

You get the idea. VCH not only has these capabilities and credentials, but we can provide them to you *in this country.* If you need help, VCH will send a specialist who talks your language and can be available in a few hours for design engineering assistance or applications advice.

Compare that with the infuriating alternatives: transoceanic phone calls and cables, garbled facts and data, and unfulfilled next-day promises.

VCH looks at commitment as much more than a management buzzword. We're putting a new plant, an eager staff, and considerable resources where our mouth is. All this shows our dedication to the proposition that…nobody is going to out-service us. Nobody.

VCH…Three letters that stand for a whole new level in miniature lamp performance. We've rewritten the industry standards before, with Chicago Miniature. Now we're ready to do it again.

We're out to be the beacon of miniature lamps.

CIRCLE NO 118

vch
INTERNATIONAL
CHICAGO MINIATURE BRAND
Buffalo Grove, IL • 312-459-3400

HOW TO END THE OPTICAL ILLUSION.

People have been talking about optical drives for years. But have you ever actually seen one work?

Well, now you can.

Because while others were talking about optical drives and solutions, Maxtor was developing them. And now we're shipping our 800MB 5¼-inch optical WORM drive in volume.

It's the first in our family of optical drives. And it's perfect for high-volume back-up, image or archival storage.

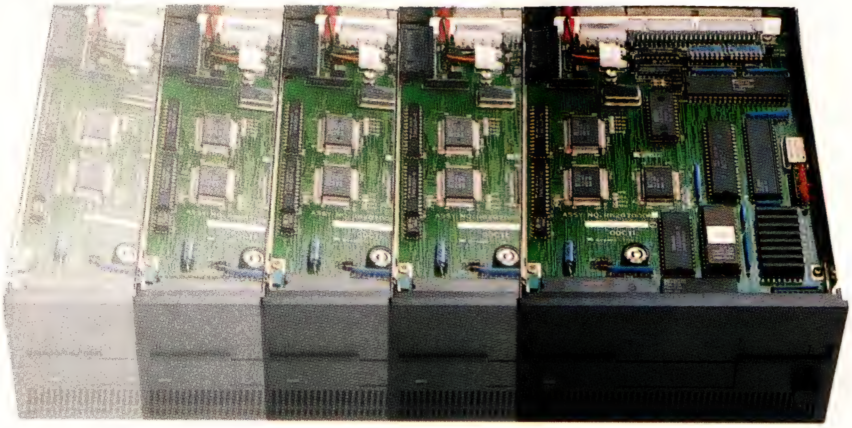
It's offered with a full complement of integration software and hardware, including media, cable and host adapter. Or it's available as a fully-configured plug-and-play mass storage subsystem.

Either way, it's fully compatible with most popular computers.

So don't wait to make optical drives a reality for your system.

Contact the Maxtor distributor or sales office listed below for complete technical and ordering information.

Because seeing is believing.



Maxtor

Sales offices: Atlanta (404) 455-4226, Austin (512) 345-2742, Boston (617) 872-8556, New Jersey (201) 747-7337, Orange County (714) 472-2344, San Jose (408) 435-7884, Woking, England (44)/4862-29814, Tokyo, Japan 81-3-431-8940.

Distributed by Anthem Electronics, (714) 768-4444, (408) 295-4200, (617) 657-5170, Future Electronics, (514) 694-7710, Pioneer Standard Electronics, Inc., (216) 587-3600, (301) 921-0660, Quality Components, Inc., (214) 733-4300, Storex Corporation, (617) 769-3400, Storage Dimensions, Inc., (408) 395-2688.

© 1987 Maxtor Corporation

Trouble in the Pacific

There's a formula somewhere that measures a country's strength by examining its economy, social structure, and political system. Unfortunately, recent newspaper and magazine reports from Pacific-rim countries emphasize economic strengths while ignoring political and social problems. If we are going to make decisions about the electronic industry's future, however, it's worth looking beneath the veneer of economics.

Among the Pacific-rim countries, Japan stands out as an economic power for others to emulate. Yet for all its economic strength, Japan has little global political stature and feels reluctant to undertake defense tasks in the northern Pacific. It's quite likely that in a confrontation between the USA and the USSR, Japan would retreat into isolationism and refuse to involve itself. Military and political strength cuts both ways. Memories of World War II haunt nearby countries that see little good in a strong Japan.

Japan faces other problems as well. For example, it confronts a lack of long-term-care facilities for older people, who are making up more and more of the population. And although it's not frequently reported, Japan also must cope with growing unemployment and the loss of heavy-industry jobs.

Korea, too, has problems. The Koreans spend heavily on defense, primarily to guard against attack from North Korea. Keep in mind that a state of war still exists between the two countries. South Korea's defense has worked for over 35 years, but much of it depends on a continuing US military presence. Future US Congresses may be reluctant to continue aiding a nation that adopts rigid protectionist trade policies. Korea must also deal with internal unrest brought about by radicals and moderates who want to overthrow or change the government.

And consider Taiwan, the Republic of China (ROC), which still lays claim to mainland China. The republic has no chance of retaking the mainland, but authorities consider any realistic talk about a separate and independent Taiwan to be seditious. The archaic Koumintang government still contains members—elected in 1947—who "represent" mainland provinces. Although both mainland China and the republic desire reunification, each has its own irreconcilable terms. The ROC also has internal problems. Only about 15% of Taiwan's population is from mainland China, yet those people dominate the country's government. The native Taiwanese want a greater say in their own affairs, but don't expect to see great upheavals in Taiwan unless mainland China presses for reunification at all costs.

The future of Hong Kong, which will revert to mainland China—the People's Republic of China (PRC)—in 1997, remains in doubt. Companies must wonder about their local investments in Hong Kong and how those investments will fare under PRC masters. The

We've been delivering high accuracy multifunction calibrators for 2 years ... others are still making promises!

While others have been promising, we've been delivering. While others have been dealing in 'futures', we've been providing solutions.

The Datron Instruments 4700 series of high accuracy multifunction calibrators is a reality and can give your laboratory these levels of performance now, with no delivery hassle:

DCV – 10nV to 1kV, 90 day accuracy to 2.5ppm.
ACV – 100nV to 1kV, 10Hz to 1MHz, 90 day accuracy to 80ppm.
Integral 1kV range to 33kHz — no need for an add-on unit to get a usable 1kV range!
Autocal — traceable electronic calibration.
Plus — Resistance, DCI and ACI Functions with IEEE-488.

And those are just the specifications for the 4707 Multifunction Standard. The versatile 4700 and 4705 models also provide superior value and performance levels specifically suited to your application needs.

Remember, you can't calibrate with a promise.

For more information or to arrange a real-time demo or evaluation of a real calibrator contact:

United States:
San Diego, Cal. (619) 565-9234
Clearwater, Fl. (813) 797-1792
Beech Grove, Ind. (317) 787-3915
Suffern, N.Y. (914) 357-5544
United Kingdom:
Norwich (0603) 404824

datron
INSTRUMENTS
A WAVETEK COMPANY

SEE US AT THE ELECTRO SHOW BOOTH #s 322 & 324

CIRCLE NO 122

EDITORIAL

Evaluating the strength of Pacific-rim countries involves more than economics. Social and political structures require a close look, too.

British refuse to discuss adopting direct representative elections—a measure that might forestall the complete PRC domination of Hong Kong's laissez-faire economy. It's unlikely that the new Chinese leaders will destroy Hong Kong's economy, but they offer only vague promises of future economic and political flexibility. So, money and people from Hong Kong are already departing for Canada and the US. Labor is still plentiful and somewhat cheap in Hong Kong, but even more laborers are available at lower rates in mainland China. Once China and Hong Kong are unified, the latter may offer few new business advantages.

The fate of the Philippines also remains unknown. Corazon Aquino's "revolution" has just about run its course. Political assassinations, kidnappings, and rebel activities once again overshadow attempts at government reform. Peace talks between the government and communist and Muslim rebels have broken down, and a renewed commitment to US military facilities is in doubt.

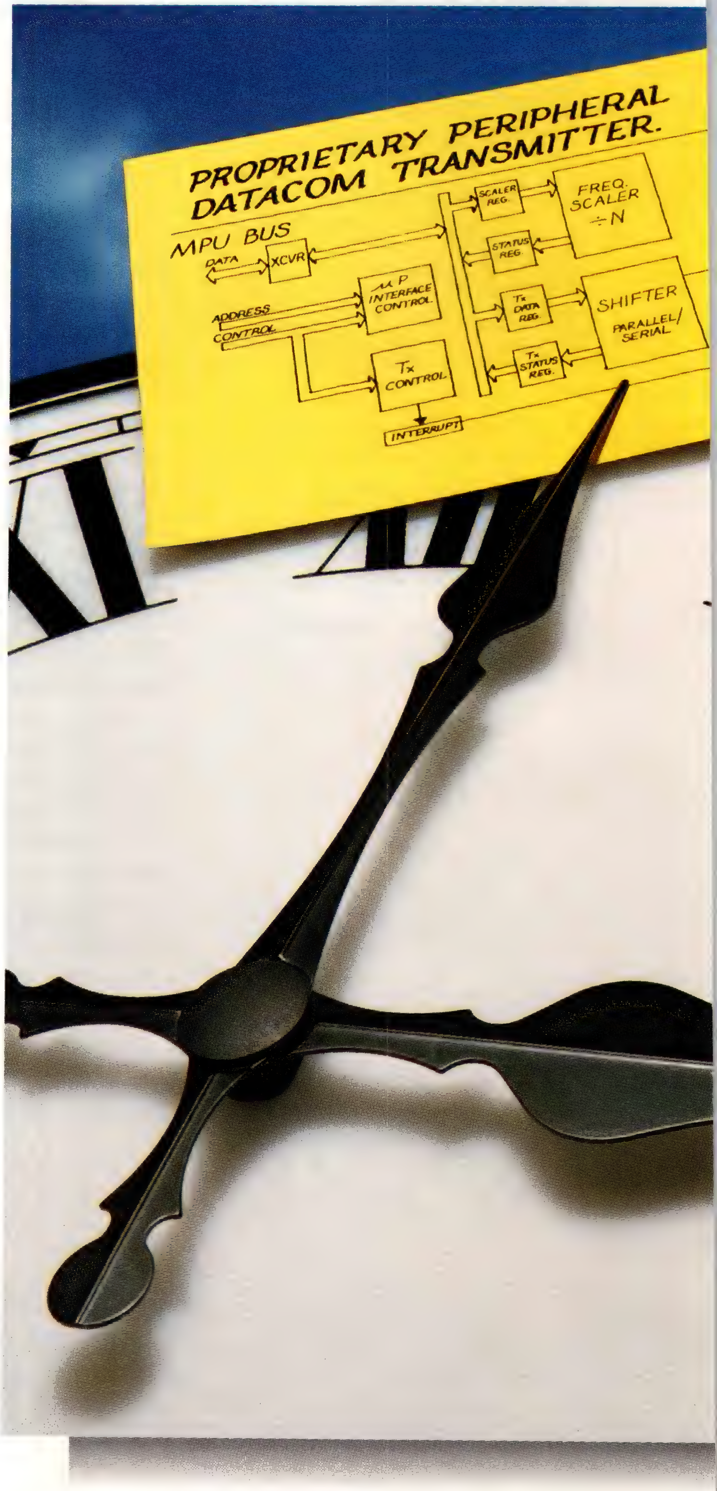
Malaysia and Singapore—important manufacturing locations—form the southern end of the Pacific's economic rim. In Malaysia, the prime minister detains people and suspends the publication of newspapers for "disturbing the racial peace." Ethnic Chinese and Indians—among the most important economic segments of the population—remain restive. In Singapore, prime minister Lee Kuan Yew has prevented the distribution of several publications that refuse to bow to his censorship. Companies with significant investments in microcode should note that Lee recently suspended copyright protection for several publications. It could happen for bit patterns, too.

All nations and governments have their share of problems, and the events and situations noted above don't portend the demise of the Pacific-rim nations. But companies that rely upon Pacific-rim countries either as suppliers or for markets must consider the long-term stability of the region. After all, Iran was once a tower of strength and our foremost ally in the Persian Gulf. How quickly events sweep away preconceived notions of stability.

Jon Titus

Jon Titus
Editor

Instant Grat



Go ahead. Indulge yourself. And say hello to BUSTER. The first user-configurable MPU peripheral. And the fastest and easiest way yet to get your proprietary design from concept to silicon.

Finally there's a way to get the off-the-shelf convenience of TTL. Without dealing with acres of board space.

In fact, with BUSTER you'll get the performance and single chip advantages of ASICs. While avoiding the painful NRE, long development cycles and inventory burdens.

You can program BUSTER for almost any peripheral function you can name. Counter/timers, data converters, configurable I/O ports, data communication transceivers and lots more.

And it'll work perfectly with just about any MPU. Including 8, 16 and 32 bit parts from Intel, Motorola, National, Zilog and others. Even when they're running at 25 MHz with no wait states.

BUSTER's amazingly flexible. It combines a fast, bus organized architecture with a powerful 20 macrocell CMOS EPLD. Giving you 52 register bits, an 8 bit I/O, cascadable to greater widths, a 24 mA bus port and a long list of other features. More than enough, in fact, to give you plenty of performance and functions for almost any application. Including those using the IBM Micro Channel bus or MIL-STD-1750A processors.

Best of all, you make it happen — concept to silicon — in hours. Not days or weeks. All you need is your PC and our powerful A+PLUS software and development system. You'll enter your design using macrofunctions based on over 100 TTL devices. And you'll program your parts in minutes. It's about as close as you can get to instant gratification.

So find out how BUSTER can help make short work of your peripheral designs. Call us today for data sheets or more information.

You'll be gratified you did.

Call (408) 984-2800.

ALTERA

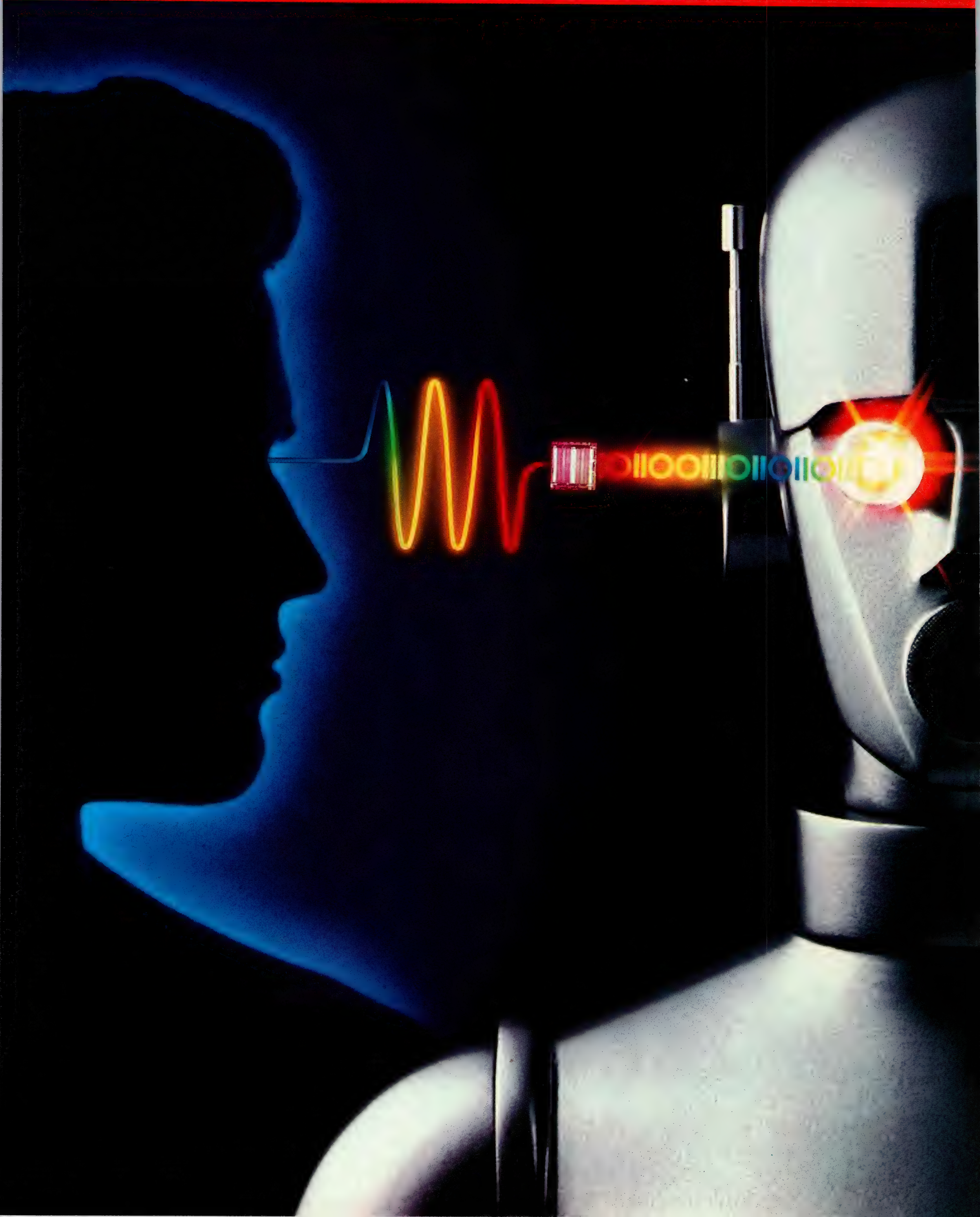
3525 Monroe Street
Santa Clara, CA 95051

© 1987 ALTERA CORPORATION.
BUSTER and A+PLUS are trademarks of Altera Corporation. IBM and Micro Channel are registered trademarks of International Business Machines Corporation.
Distributed in U.S. by Alliance, Pioneer, Quality Components, Schweber, Wyle and Hall-Mark. In Canada, distributed by Future and Semad.

CIRCLE NO 117

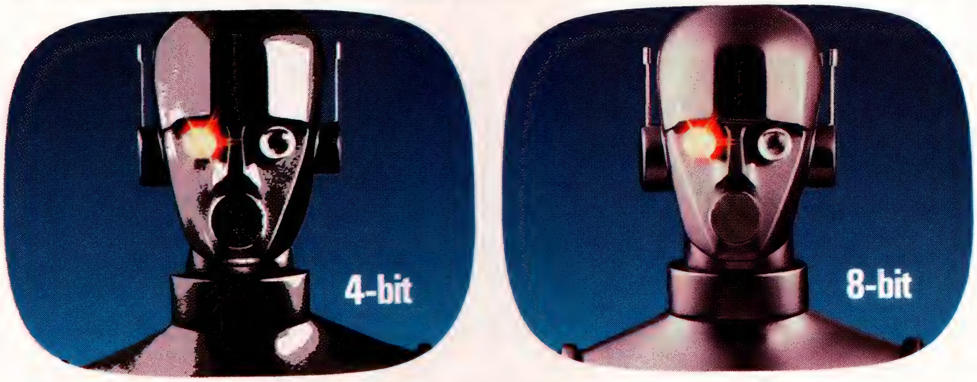
ification.

High-resolution conversion



in the blink of an eye.

Get video speed, low power consumption, high resolution and superior price/performance with our new CMOS data converters.



We've expanded our line to include more CMOS flash ADC's, a charge balancing ADC, an SPI ADC and a DAC. All featuring single 5V supply operation.

We also offer a new high-speed op amp especially well-suited to driving ADC's or video cables.

4, 6 and 8-bit CMOS flash ADC's.

Choose from 4, 6 and 8-bit ADC's. All operate at video speeds, with clocking speed and input bandwidth specified at 5V. What makes these flash ADC's special is silicon-on-sapphire construction, resulting in low cost, high speed, very low input capacitance, low power consumption and inherent latch-up resistance.

10-bit CMOS charge balancing ADC.

This 10-bit successive approximation ADC captures fast moving signals, providing excellent resolution.

It features a built-in fast track and hold, with conversion rates of 150 KHz and an input bandwidth of 1.5 MHz. Even at the maximum rate, power consumption is less than 20 mW.

10-bit CMOS serial ADC.

The CDP68HC68A2 is selectable for either 8- or 10-bit resolution and has an 8-channel multiplexer allowing up to 8 channels of inputs. The device can be used directly with our CDP68HC05C4, C8 or D2 microprocessors or other similar SPI (Serial Peripheral Interface) buses.

8-bit CMOS R-2R video-speed DAC's.

These CMOS/SOS digital-to-analog converters operate from a single 5V supply at video speeds and can produce "rail-to-rail" output swings. Typical update rate is 50 MHz. Settling is fast (20 ns typical) to 1/2 LSB. "Glitch" energy is minimized by segmenting and bar graph decoding of upper 3 bits.

High-speed op amp.

Specially designed for use with data converters, the CA3450 op amp has excellent speed and transmission line driving capabilities.

For 10-bit accuracy, it settles to within 1/2 LSB in 40 ns with a 2V input signal. And it can drive up to four 50 ohm transmission lines.

ADC's	*Res. Bits*	*Conv. Rate Hz*	*Power Diss. (MW)*	*Pkg. Leads*	*1K Price*
CA3304E	4	20M	30	16	2.95
CA3304AE	4	25M	35	16	4.50
CA3306CE	6	10M	65	18	5.50
CA3306E/3306AE	6	15M	70	18	6.25/11.25
CA3318E/3318CE	8	15M	150	24	38.50/24.00
CA3310E/3310AE	10	150K	15	24	6.00/8.00
CDP68HC68A2E	10	10K	15	16	3.75
DAC's					
CA3338E/3338AE	8	50M	100	16	6.00/8.40
OP AMP	*UGBW Hz*	*Slew Rate (X10)*	*I_{OUT} MA*	*Pkg Leads*	*1K Price*
CA3450E	200M	300V/μSec	±75	16	2.70

Data in a flash.

For data sheets of these new products, call toll-free 800-443-7364, extension 19. Or contact your local GE Solid State sales office or distributor.

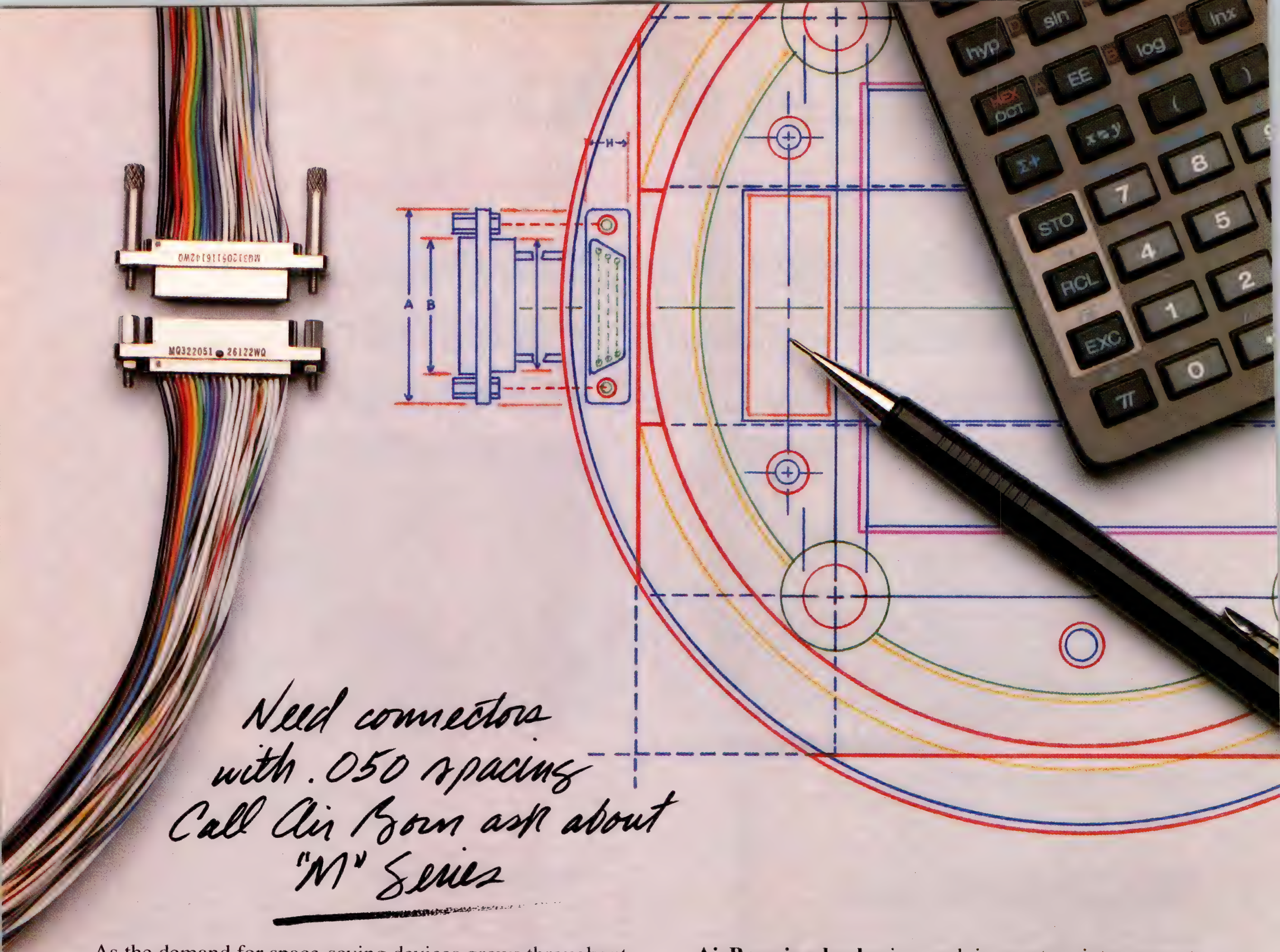
In Europe, call: Brussels, (02) 246-21-11; Paris, (1) 39-46-57-99; London, (276) 68-59-11; Milano, (2) 82-291; Munich, (089) 63813-0; Stockholm (08) 793-9500.

*

GE Solid State

GE/RCA/Intersil Semiconductors
Three great brands. One leading-edge company.

*Trademark of General Electric Company, U.S.A., not connected with the English Company of a similar name.



As the demand for space-saving devices grows throughout the electronic industry, the designer is faced with specifying smaller and smaller components without sacrificing quality or reliability.

For the designer, the logical choice in space-saving, versatile connectors is the Micro-Mate® "M" Series .050″ connector from AirBorn. Providing as much as 75% reduction in area requirements, the Micro-Mate is suitable for a wide variety of applications. Weapon guidance and control systems, military computers, communication and navigation systems, radar, electronic warfare, avionics, electro-optics and submarine systems are just a partial list.

The "M" Series is on the Qualified Products List with a military specification number of MIL-C-83513/1 through 9. Besides conforming to military specifications, other features include high density, high reliability, electroless Nickel shells for space applications, and AirBorn's reputation for high quality. Available in metal or plastic, rugged or low-profile, I/O or board-mounted versions, the Micro-Mate comes in the following sizes, with others available upon request from the factory.

1-row	up to 120 contacts
2-row	9-, 15-, 21-, 25-, 31-, or 37 contacts
3-row	51 contacts
4-row	100 contacts

The Micro-Mate features low force pin contacts with half the maximum insertion force of a typical twist pin design.

AirBorn is a leader in supplying custom interconnect solutions (PWB mount, surface mount, EMI/RFI shielding, etc.) in the military electronic market based upon years of expertise, innovation, quality technology and customer service.

- **"M" Series**
  For pricing, design criteria and delivery information on the "M" Series Micro-Mate, call the "M" Series HOTLINE at 512-863-0500.
- **Other Products**
  For information on AirBorn's .075″ "R" Series connectors or Airborn's .100″ "W" Series connectors, call the "R" and "W" Series HOTLINE at 214-931-2800.

The designer who wants the most effective solution for space-saving interconnect requirements will choose AirBorn's Micro-Mate.

AirBorn

4321 AirBorn Drive
P.O. Box 519
Addison, Texas 75001

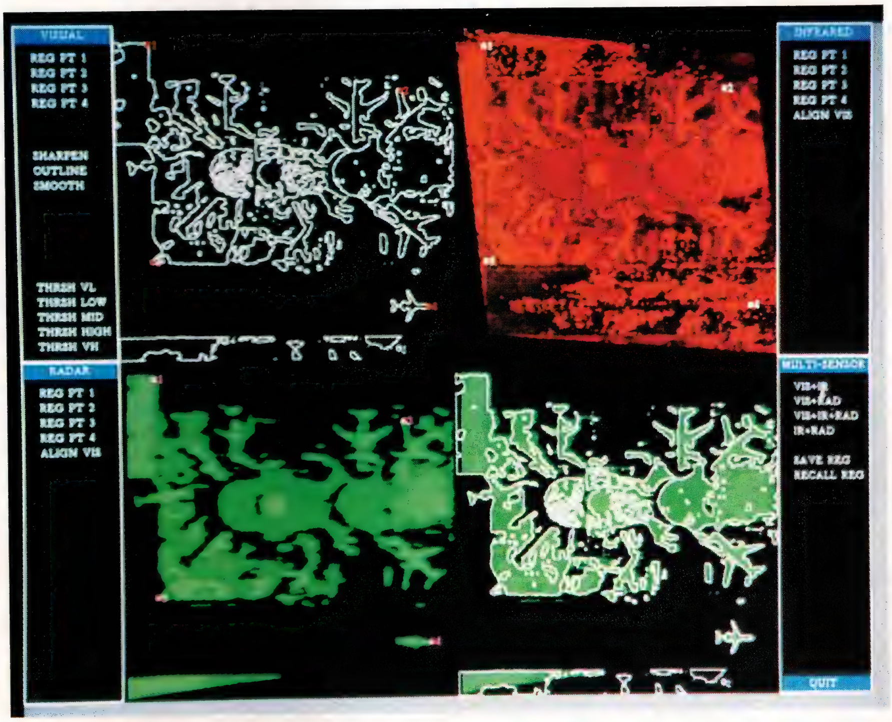
CIRCLE NO 119

Sophisticated hardware and software beget efficient machine-vision systems

J D Mosley, *Regional Editor*

Because of recent developments in machine-vision technology, you no longer need a lot of specialized knowledge to develop vision systems that let machines search for and differentiate among patterns. You can now choose from an assortment of systems, subsystems, boards, and software packages that let machines efficiently perform such real-world tasks as examining ICs for defects or scanning products on conveyor belts.

Your choice of machine-vision equipment depends on your application and the amount of money you have to spend: The available products range from expensive, standalone vision systems that you can integrate in production equipment, to moderately priced boards for workstations or personal computers, to sophisticated software algorithms that let you create customized vision systems with standard hardware.



In darkness or over long distances, machines can "see" better than humans *by combining a variety of sensor data obtained from a single scene. Visual Information Technologies' Model 120 uses four Parallel Image Processors (Pips) to perform parallel operations on multispectral data. The operations shown are visual with edge enhancement (top left), infrared (top right), radar (bottom left), and all three operations fused by the windowing and overlay operations (bottom right). (Visual data courtesy Hughes Aircraft)*

Using radar, infrared, and image-enhancement techniques, state-of-the-art machine-vision systems can literally see in the dark or identify microscopic imperfections in a surface. By using sophisticated pattern-recognition algorithms based on artificial-intelligence (AI) paradigms, the systems can identify and analyze images in such applications as government surveillance, semiconductor inspection, film colorization, and robot guidance.

Recognition Technology, a Westborough, MA, image-processing company, describes machine vision as a cycle that begins with image acquisition, proceeds to image storage, then continues with image enhancement, feature extraction, data reduction, recognition and decision making, and further data reduction. The cycle then repeats. Current machine-vision systems can perform the steps of this cycle fairly well, but they can't always perform them in real time. For example, in 1984, a robot called Neptune used a vision system to negotiate an obstacle-strewn 35-ft room at Carnegie Mellon University—but it took more than an hour to do so.

Consider the challenge of processing and analyzing the visual information contained in a 2-dimensional television picture, in which more than one million pixels change thirty times a second. Adding the third dimension further complicates the analysis. In computer terms—according to Cognex Corp, a manufacturer of machine-vision systems—the human brain performs approximately 100 billion logical floating-point operations per second (flops) just to see objects and determine what they are. That performance is 400 times that of a Cray-1 supercomputer.

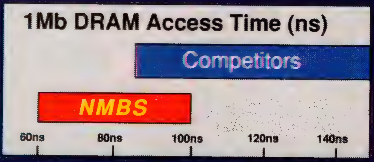
AI simplifies the task

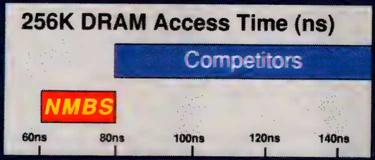
Although you can't yet provide a machine with vision equivalent to human sight, you can focus the present technology to perform useful operations by limiting the scope of each specific vision task. For example, Cognex Corp uses artificial-intelligence (AI) techniques to modify a vision procedure that the company

DRAMATIC!

Now...Highest speeds AND production... 60/70/80ns 1Mb AND 256K DRAMS...

Exclusively from NMB Semiconductor - the high speed DRAM specialist - we've broken the speed barrier with FutureFast™ 256K and 1Mb DRAMS...first with access times of 60/70/80ns. This means designers can now have true "0" wait state systems without using complex, expensive cache memory techniques.

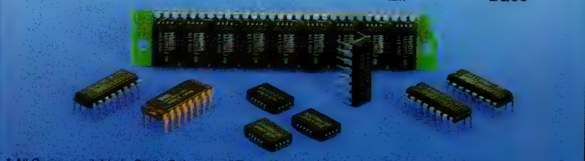

1Mb DRAM Access Time (ns)


256K DRAM Access Time (ns)

We've broken the delivery barrier too. NMBS offers much higher volume production than our competitors. These dramatic advances are made possible in the most advanced CMOS/VLSI plant in the world optimized for volume production of high speed DRAMS. With computerized operation and robot control in Class 1 ultra-clean rooms. Plus state-of-the-art design, processing and testing.

Product Line Summary

Series*	Access Time	Organization	Package**	Availability
AAA2800 256K	60/70/80 (ns)	256Kx1	P-DIP PLCC C-DIP	Production Production Production
AAA1M100 1Mb	100/120 (ns)	256Kx4 1Mbx1	P-DIP SOJ ZIP	Production Production Production
AAA1M200 1Mb	60/70/80 (ns)	256Kx4 1Mbx1	P-DIP SOJ ZIP	2Q88 2Q88 2Q88



* All Series available in Static Column and Page Modes ** SIMM'S and SIPS available for each series

Available in the packages and organizations designers want for high performance projects.

More good news. We're now shipping qualification samples of our new 1Mb DRAM.

So for complete specs, evaluation units, quantity prices and delivery call NMBS - the high speed DRAM specialists - today. Prove to yourself that with FutureFast™ DRAMS, your future is now.

NMB | **NMB SEMICONDUCTOR CORPORATION**

11621 Monarch Street•Garden Grove, CA 92641
Telephone: (714) 897-6272
FAX: (714) 891-0895•TLX: 67-8486

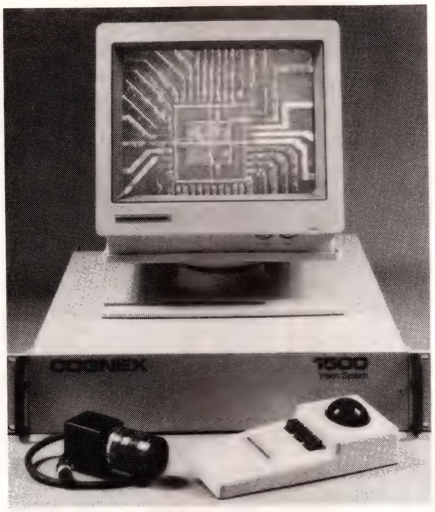
FUTUREFAST™
...IS NOW.

CIRCLE NO 123

refers to as "searching." Instead of resorting to intensive calculations to compare a stored image with a sample image—a process called "template matching"—Cognex scans the sample image at low resolution and uses AI-based algorithms to make intelligent guesses about where objects should be within the image. This searching technique can give a single pc board an equivalent throughput rate that's 30 times faster than that of a Cray-1 performing traditional template-matching calculations at its maximum speed, 1000 MIPS.

The company's latest product, the Cognex 1500, is a $10,000 subsystem that can analyze the input from as many as four video cameras to locate objects and determine their positions. The 1500 was specifically designed to address the needs of OEMs and system integrators that design automated equipment for pc-board production, machine guidance, and alignment. The Cognex 1500 includes a rack-mountable chassis, a solid-state video camera, a monochrome video monitor, a trackball, cables, software, and documentation. You must supply an IBM PC to control the system via an RS-232C connection. The software's pull-down menus let you access the 1500's set of 25 instructions. You use the trackball to manipulate the cursor and to select commands, objects, and search regions.

The 1500 uses gray-scale pattern matching to locate objects and features in a scene. This method is more flexible and consistent than binary pattern-matching techniques, and it provides accuracy of better than ±0.001 in. It helps the 1500 achieve processing times ranging from 0.050 to 0.500 sec, depending on the desired accuracy, object size, and scene complexity. In addition, the embedded image-analysis algorithms let the 1500 identify the correct pattern even when the image is degraded, or when changes in color, reflectance, orientation, or contrast occur. Even a poorly focused lens will not prevent the system from correctly identifying a pattern; however, the company does note a reduction in image quality on a 1000-part scale.



Able to overcome such real-world problems as a defocused lens *or reduced contrast caused by poor lighting, a $10,000 (OEM) Cognex 1500 starter kit includes an electronics module, a video camera, a lens kit, a monitor, a trackball, cables, and documentation. You supply the PC host, which communicates with the 1500's electronics module via an RS-232C link.*

The correlation values produced by the gray-level pattern-recognition technique are statistically normalized for image gain and offset. Thus, the technique is insensitive to variations in light intensity and contrast even within a single image. Placing a colored filter over a portion of the object won't prevent the Cognex device from identifying the object.

The 1500 identifies the x and y coordinates of the pattern, and it comes with calibration software that translates the visual data on the screen into the corresponding real-world units of measure. It can thus permit a robot to reposition misaligned objects. The 1500's vision-processor board includes a 12-MHz MC68000 μP, an image digitizer with a resolution of 576×448 pixels and with 64 gray levels, as much as 2M bytes of dynamic RAM, a 512k-byte ROM, 128k bytes of battery-backed CMOS RAM, and a proprietary vision coprocessor that implements pattern matching in hardware. This proprietary vision IC is a custom circuit that interprets images through gray-scale normalized correlation; it interfaces to any 68000-family CPU. The 1.5-μm CMOS chip can perform normalized correlation three times faster than a board-level circuit, yet costs one-tenth as much.

For designers who want more extensive vision capabilities, the company also offers the Cognex 2000/DS vision-development system, which lets you write custom application programs in C on your IBM PC or compatible computer. As soon as you have debugged an application program, you can download it to a floppy disk or burn it into EPROMs to transfer full control to the 2000/DS. You need the PC only for editing, program development, and downloading.

The 2000/DS performs the same functions as the 1500, but adds image processing to manipulate its output, as well as development access to C function calls and programming utilities. The 19-in., fan-cooled, rack-mountable chassis contains a single-board vision processor (the chassis has slots for as many as four vision-processor boards), a card-cage/backplane assembly, a power supply, an 800k-byte floppy-disk drive, three RS-232C ports, six TTL digital-input ports, four TTL digital-output ports, and a 64-byte I/O expansion port. The 2000/DS also comes with a 12-in. monitor, a trackball, cables, a solid-state camera, system software and utilities, searching software, character-recognition software, inspection software, a communications program, and a text editor.

Adaptive automation meets Mac

Another challenge that developers of machine-vision systems face is that of allowing systems to adapt to changes in their environment. To enable machines to react to changes in industrial surroundings and to adjust to variations in parts, manufacturing processes, object location, and equipment speed, Automatix Inc combines standard sensors and controllers with application-specific software to create a variety of "adaptive automation" systems.

Automatix, which has already installed more than 1000 of these systems, offers a broad line of machine-vision products. Microspec, for example, is a $100,000 SMD-inspection system that examines pc boards for missing, misplaced, or incorrectly oriented components. Partracker is a software package that locates parts and solves fixturing and fit-up problems prior to robot manipulation; Seam Tracker is a vision-guided welding system. The firm also offers AI 90, an $8500 ruggedized Macintosh II-compatible computer for industrial applications, and Autovision 3, a $17,500 menu-driven vision and robot-guidance system. Every customer that purchases an Automatix product receives membership in Acuity, an international user group for industrial vision systems.

Central to the Automatix concept of adaptive automation is the Rail programming language. This proprietary interpretive language is written in C and is designed for vision processing, high-speed calculations, and robotic control. It includes algorithms for edge detection, gray-scale gradient detection, convolution filtering, structured light analysis, and connectivity analysis. With this language, your system can control as many as 16 cameras. The interpreter includes diagnostic software. Rail comes with all Autovision systems; you can order the source code under a special licensing agreement.

For $23,000, you can also order

Neural networks help a system learn to see

Machine-vision systems represent an attempt to give machines an analog to human vision that robots and other types of computer systems can use. To improve the way machines understand and use this sensory data, engineers are using an artificial-intelligence technology called neural networks.

Neural networks are intended to emulate human learning patterns; they contain loosely coupled processing elements, or nodes, that compute activity locally and share those computations with other nodes according to a weighted transfer function. Their goal is to mimic the way human brain cells exchange information and to mimic the way the brain weights the information transfer among brain cells.

Nestor Inc, which was founded in 1975, is reportedly the oldest of the neural-network companies. The company has adapted this parallel-processing-oriented technology for use with serial-processing von Neumann hardware—specifically with IBM PC/ATs, Sun workstations, and Apollo workstations. The $25,000 Nestor Development System (NDS) uses neural-network technology to solve a wide variety of pattern-recognition problems. To use the system, you need a PC/AT or Sun or Apollo workstation with at least a 1.2M-byte floppy-disk drive, 640k bytes of RAM, and a 20M-byte hard-disk drive. If you use a PC/AT, you must have an EGA- or VGA-compatible interface and monitor, MS-DOS 3.0 or higher, a Microsoft C compiler (version 4.0 or higher), and a Microsoft mouse. You must use C for software development—all of the NDS code is written in C, although portions of the training program and the code described in the tutorial are supplied by the manufacturer as source code.

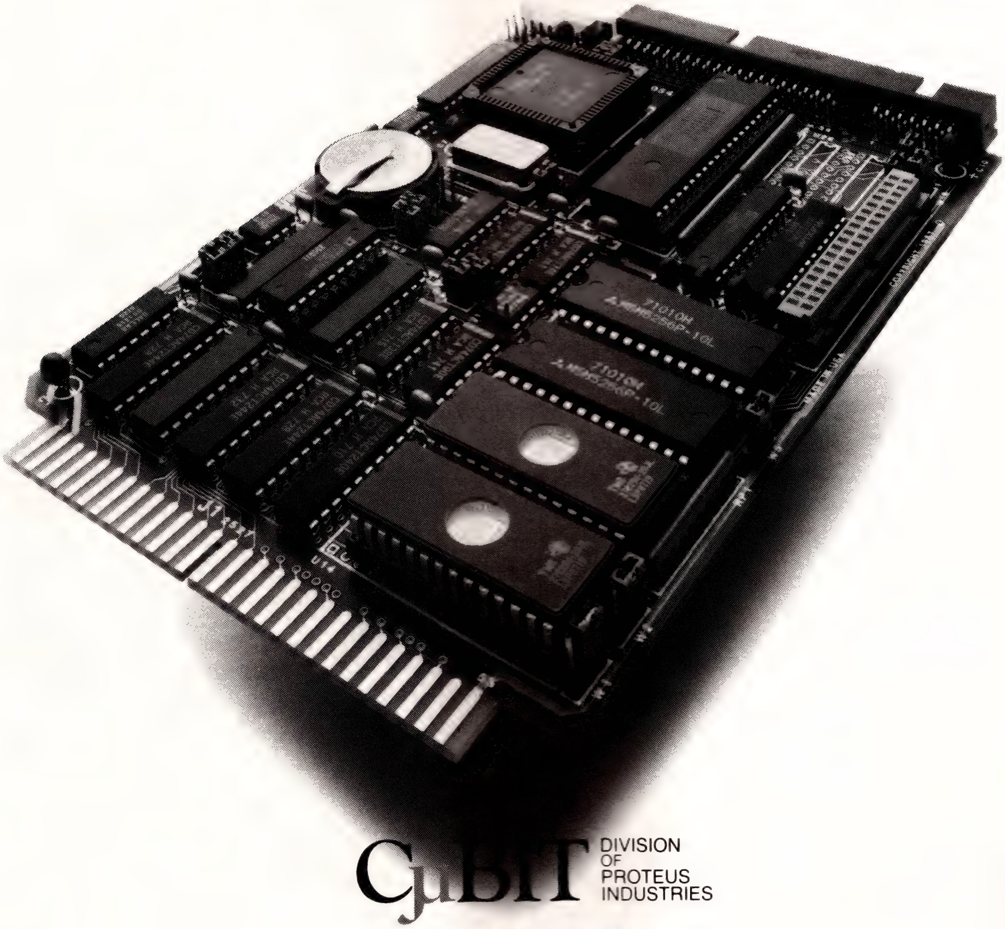
The resulting system generates a Restricted Coulomb Energy (RCE) neural network. The network develops weighted pattern maps, solving categorization problems by assigning probability estimates of complex relationships to the relevant variables. The RCE network is a patented model that uses three processing layers. The input layer has nodes that register the value of a feature of the input. The output layer has nodes that correspond to a pattern category; the fewer the output nodes triggered by a certain input, the less ambiguous the input and the greater the certainty about a pattern's identity. The internal layer of nodes constructs the mapping that will trigger the correct output node in response to a given input pattern. The network "learns" by adjusting internal-node thresholds with training signals that move from the output layer back into the internal layer.

In an RCE network, memory is stored in weight vectors between the input layer and the internal layer. Training affects only areas of the memory associated with local vectors, therefore. Accordingly, Nestor's RCE network lets you add new information without retraining the entire system; you address only the nodes associated with a particular vector threshold.

To use the Nestor Development System, you must write a feature-extractor program. The company provides examples of feature extractors in C source code. You then train the system by presenting it with a series of classified patterns; the system batch processes the patterns and uses them to define the system architecture and to store the training/testing protocol.

CμBIT FOR V40 ON STD BUS.

V40 PROCESSOR RUNS AT 7.4 MHz
8088 CODE COMPATIBLE
ALL CMOS
64K BATTERY-BACKED RAM
128K EPROM
TWO RS-232/RS-485 LINES
THREE 8-BIT PARALLEL PORTS
BATTERY-BACKED CLOCK CALENDAR
SBX CONNECTOR
8-BIT, 8-CHANNEL A/D CONVERTER
DEBUG FIRMWARE LINKS TO PC



CμBIT DIVISION OF PROTEUS INDUSTRIES

190 S. Whisman Road
Mountain View, CA 94041-1577
Telephone: (415) 962-8237

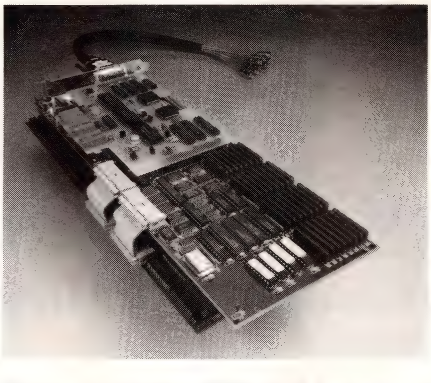
CIRCLE NO 124

the Automatix Lab Development Package, which is based on the Autovision 3 and includes a CCD camera, cables, lenses, Rail, two floppy-disk drives, a 12-in. CRT, a keyboard, and manuals. The package comes with an assortment of software, including a menu-driven visual gauging system, a program that increases the speed of selected connectivity calculations, a program that identifies parts by their silhouettes, a program that uses convolution operations to locate and analyze edges and lines, a program that calculates and compares gray-scale averages and histograms, and a program that performs arithmetic and logical operations on the contents of pixel buffers.

Image processing gets smart

If you don't want to spend the money for a programmable vision system, you might be able to get away with using an image-processing system instead. Image processing is only a subset of the complex task of machine vision, but vendors have recently introduced some more-advanced image-processing systems that may be able to take the place of full-fledged vision systems in certain applications. For example, Visual Information Technologies Inc (Vitec) offers "image computers," systems that do more than mere image processing. According to the company's definition, image computing comprises computer graphics, image processing, and image analysis.

An example of a type of image computing is multisensor fusion. By combining, or "fusing," data from different sensors, a system can provide information that's more useful to you than the separate output from individual sensors. For example, Vitec's image computers can perform multisensor fusion by using Parallel Image Processor (Pip) chips to perform parallel operations on multispectral data gathered from the same scene by different sensors. The Pips are custom VLSI array processors that are specifically equipped to handle computation-intensive tasks such as convolution filtering, scaling, rotating, zooming, blending, and pixel replication.



Plug-in boards for PC-based image processing *such as Data Translation's DT2871 color frame-grabber board) let you perform gray-scale processing, hue and saturation processing, and frequency-domain analysis at capture and display rates reaching 30 frames/sec. The DT2871 plugs into the DT7020 floating-point array processor to boost system performance during computation-intensive operations such as color edge detection, compression, and FFT analysis.*

To perform multisensor fusion on data gathered from an aircraft, for instance, you could have one Pip perform image-enhancement and edge-detection operations on visual data from a video camera while another Pip processes infrared data. At the same time, a third Pip could process radar data, and a fourth could perform windowing and overlay operations on the three types of data. By combining the visual, infrared, and radar data and fusing the result, you can greatly enhance your ability to interpret the data.

Vitec offers two image-computing systems, Model 100 and Model 120, which start at $30,000. Model 100 has four Pips that can execute 122 MIPS; four 27-MHz video processors; 6M bytes of image memory; and a 13-in., 640×480-pixel RGB monitor. The Model 120 comes with four Pips that can execute 160 MIPS; four 107-MHz video processors; 10M bytes of image memory; and a 19-in., 1280×1024-pixel RGB monitor. Each model also comes with a 16.67-MHz 68020 CPU; a 68881 floating-point coprocessor; a 32-bit VME Bus; a 140M-byte, hard-disk drive; a 60M-byte, ¼-in. tape drive; a 94-key keyboard; and a 3-button optical mouse.

The systems also come with several software packages: Vitec's Image Display List System (IDLS) for application development; an interactive IDLS script interpreter; an IDLS script-to-C translator (preprocessor); a version of the X-Windows program (developed at MIT) that has enhanced imaging features; the company's Imaging Window and Menu Tools (IDLX); a primitive module for image and graphics algorithms; and Unix, which is integrated with the Network File System (NFS).

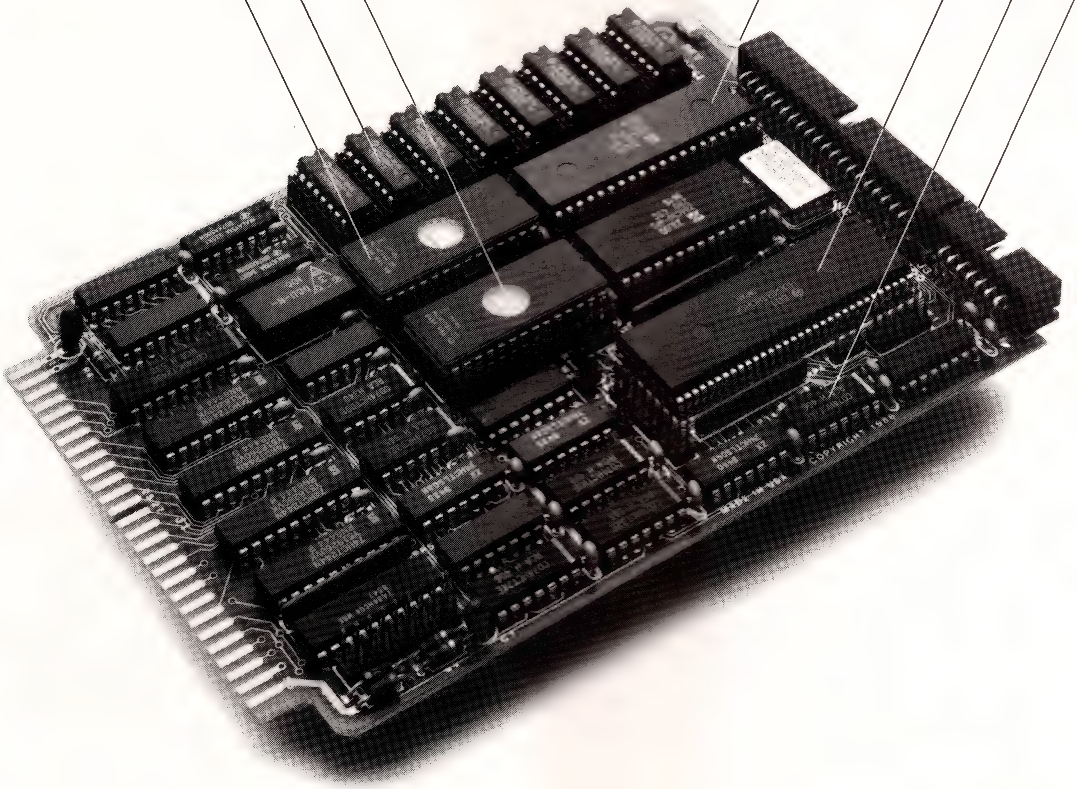
Machines that have x-ray scanning abilities can outperform human inspectors on assembly lines, because the machines can evaluate products without destroying them. Advanced Research and Applications Corp (Aracor) manufactures industrial test and inspection instruments based on a technique called computed tomography (CT). This technique passes a collimated x-ray beam through a test object to render a cross-sectional image of that object. A CT image displays more than 1000 times more information than conventional x-ray film processes do.

Aracor has transferred this technology to the Model 4100 automatic semiconductor-irradiation system, which tests the radiation tolerance and latch-up immunity of electronic devices and ICs at the wafer stage of production. The system is available in three configurations: The $163,000 Model 4100 XP measures only radiation hardness; the $259,000 Model 4100 PL provides independent testing for latch-up and radiation hardness; and the $310,000 Model 4100 XPL integrates and automates the radiation and latch-up tests.

Another way to build a machine-vision system is to buy image-processing software for use on one of the major workstations and hook up

CμBIT FOR 64180 ON STD BUS.

TWO 8 BIT PARALLEL PORTS
TWO SERIAL LINES
SOFTWARE LINKS TO PC
UP TO 256K DRAM
UP TO 128K EPROM
ALL CMOS VERSION AVAILABLE
64180 CPU RUNS 280 CODE



CμBIT DIVISION OF PROTEUS INDUSTRIES

190 S. Whisman Road
Mountain View, CA 94041-1577
Telephone: (415) 962-8237

your own video camera for gathering data. Logica Inc's Vista-IPS tool kit, for example, is a hardware-independent software-development environment for image-processing algorithms. It has a multiuser environment and two separate user interfaces—one is a high-level interface that offers commands that resemble Basic; the other is a low-level programming environment that lets you use Vista-IPS utilities to develop image-processing primitives in your host computer's high-order program-development language.

Vista-IPS provides access to more than 200 primitives supplied in Fortran source code. You can nest as many as nine levels of test procedures for flexibility at the experimentation and design phases of the development process. The software package also assists you in converting the hardware-independent algorithms you've generated for use with the target hardware. Vista-IPS uses foreground/background processing to speed the development cycle, and it supports both interactive and batch processing. Its Autoload command provides automatic loading of procedures and primitives, and its windowing facility enables you to process smaller portions of an image or "subimages."

Vista-IPS is available for DEC VAX and MicroVAX computers running VMS or MicroVMS and for Masscomp 5000 Series computers running the RTU operating system. You must also use a Fortran compiler with Vista-IPS. Prices range from $6000 for a single-user license to $20,000 per copy for multiuser systems.

Menu-driven library

Recognition Technology offers a menu-driven library of routines written in (and callable from) the C language. The library lets your IBM PC, Multibus, or VME Bus host control the company's line of image-processing boards and subsystems. The $1795 library, RTILib/500, contains more than 300 routines that are specifically developed for machine-vision and image-processing applications. For dedicated applications, you can bypass the menu-driven executive.

The library is structured in three layers. You use the interactive, menu-driven executive layer to execute most of the RTILib/500 subroutines. The layer of high-level, C-callable subroutines performs such functions as image transforms and utilities, spatial and temporal filtering, region growing, arithmetic and statistical operation, and graphics processing. The third layer is a layer of low-level primitives and macros that provides access to the control and status registers and data tables of the various image-processing hardware modules.

RTIExec includes the Fundamental Vision Tools Menu, which has 16 screens, each offering seven to 17 additional selections. A help menu and a menu of utilities are accessible from all the other menus in RXIExec. Because most of the menu-driven commands have a one-to-one correspondence with RTILib's C-callable routines, you can quickly translate a string of menu calls into a dedicated program.

The company's latest subsystem that uses the RTILib/500 software package is the RTI-Station, a stand-alone box that connects to your IBM PC, Sun or Masscomp workstation, Multibus host, or VME Bus computer. For real-time performance, the unit includes a 10-MHz pipeline pixel processor that passes 18 bits of data bidirectionally on each clock cycle. To avoid overloading the host computer's bus, the RTI-Station contains multiple synchronous video buses for high-speed image transfers. You can store as many as 20 images on line in the RTI-Station's digital-image-storage boards. The unit digitizes each pixel of data as 8 bits of gray-scale information; thus, it provides 256 gray levels at an active-area resolution of 512×512

For more information . . .

For more information on the vision systems described in this article, contact the following manufacturers directly, circle the appropriate numbers on the Information Retrieval Service card, or use EDN's Express Request service.

Advanced Research and Applications Corp (Aracor)
425 Lakeside Dr
Sunnyvale, CA 94086
(408) 733-7780
Circle No 710

Automatix Inc
1000 Tech Park Dr
Billerica, MA 01821
(617) 667-7900
TLX 951518
Circle No 711

Cognex Corp
150 Gould St
Needham, MA 02194
(617) 449-6480
TLX 948022
Circle No 712

Data Translation Inc
100 Locke Dr
Marlboro, MA 01752
(617) 481-3700
Circle No 713

Datacube Inc
4 Dearborn Rd
Peabody, MA 01960
(617) 535-6644
TWX 710-347-0125
Circle No 714

Digital Vision Inc
66 Eastern Ave
Dedham, MA 02026
(617) 329-5400
Circle No 715

Imaging Technology Inc
600 W Cummings Park
Woburn, MA 01801
(617) 938-8444
Circle No 716

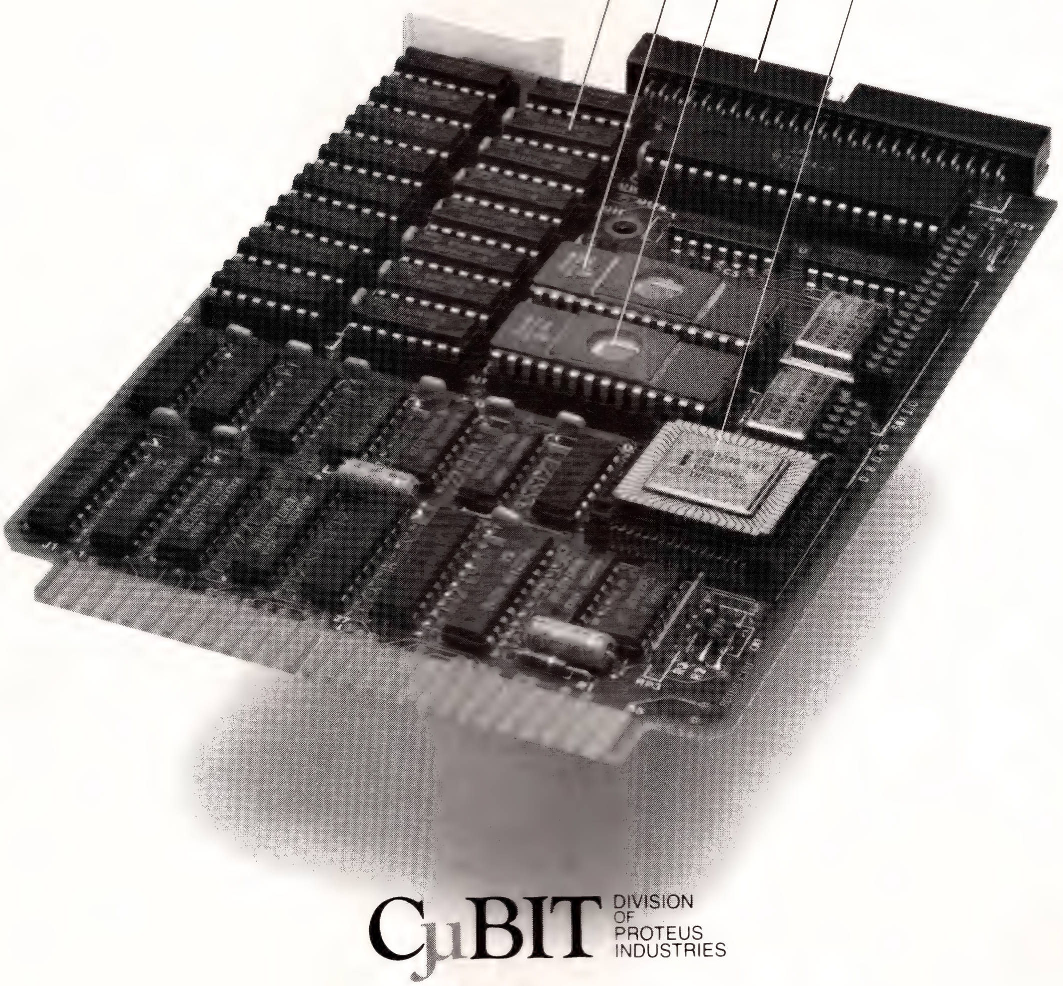
Logica Inc
3 Embarcadero Center
Suite 1720
San Francisco, CA 94111
(415) 397-0496
Circle No 717

Nestor Inc
One Richmond Square
Providence, RI 02906
(401) 331-9640
TLX 272848
Circle No 718

Recognition Technology
160 E Main St
Westborough, MA 01581
(617) 366-4800
Circle No 719

Visual Information Technologies Inc (Vitec)
3460 Lotus Dr
Plano, TX 75075
(214) 596-5600
Circle No 720

CμBIT FOR 80186 ON STD BUS.



CμBIT DIVISION OF PROTEUS INDUSTRIES

190 S. Whisman Road
Mountain View, CA 94041-1577
Telephone: (415) 962-8237

CIRCLE NO 126

pixels. Prices for the RTI-Station start around $10,000.

Faster-than-real-time imaging

Offering an 8-bit image-processing speed faster than 1/30 sec on a PC/AT-type computer, the Series 151 subsystem from Imaging Technology connects to your IBM PC/AT or VME Bus computer via a proprietary interface that lets the PC/AT control the subsystem's operation. This $11,495 package gives you RS-170, RS-330, and CCIR 8-bit video acquisition. Its onboard, dual-ported frame memory can store multiple images. The 151's pipeline processing and expandable architecture enhance the subsystem's performance. Its I/O look-up tables and read/write registers facilitate such image-manipulation features as RGB pseudocolor output, graphic overlays, real-time convolutions, and real-time histograms.

The subsystem uses separate boards for its A/D interface (ADI-151), frame buffer (FB-151), pipeline processor (ALU-151), real-time convolver (RTC-151), and histogram/feature extractor (HF-151). The subsystem also uses separate buses for video data from the A- and B-frame stores, for graphic overlays, for video pipeline data, and for the video data input.

The A/D interface includes an 8-bit digitizer, programmable gain and level, and a 24-bit color display. To increase the on-line storage capability, you can plug as many as four of the frame buffers into the subsystem; each buffer contains one 16-bit frame store and two 8-bit frame stores. Automatic spin compensation adjusts for pipeline-processing delays. The pipeline processor performs three types of real-time image processing: arithmetic, logical, and bit-plane oriented. The histogram/feature extractor offers 10-bit histograms and performs feature extraction of as many as 16 features simultaneously.

The Series 151 subsystem comes with a driver-level software package called Toolbox that helps you integrate the subsystem with your host computer. You can order Itex, an optional subroutine library of image-processing functions, which includes programs for look-up-table operations, image save and restore, graphics functions, area and image geometry, image analysis and point processing, and linear/nonlinear operation. The company's line of image-processing products ranges from the $1995 PCVision+ frame grabber (for IBM PCs and compatibles) to the $28,995 Series 200 image-processing subsystem for (MicroVAX II hosts).

PC/AT-based vision systems

Another alternative to buying a costly, dedicated machine-vision system might be to develop a vision system for your IBM PC/AT gradually. For example, you could choose from the plethora of plug-in image-processing, array-processing, and data-acquisition boards that Data Translation offers, and mix and match the boards to design a custom system. The company's latest image-processing board is the $2995 DT2871, a color frame grabber with a Hue-Saturation-Intensity (HSI) chip set, which converts the red-green-blue (RGB) images from a color video camera to hue, saturation, and intensity values in 1/30 sec. The DT2871 captures images in 512×512-pixel resolution; each pixel represents one of 16,777,216 colors.

The benefit of converting RGB images to HSI values is that each H, S, and I value can be processed independently of the other two values. You can therefore perform operations on the visual data that you can't perform on mere RGB images. For example, to learn about the frequency and distribution of the image's colors, you can generate a histogram from just the hue values. To enhance edges or remove white noise from a color image, you can perform a convolution on just the intensity values.

Because manipulating the hue, saturation, or intensity of an image is simpler and faster than manipulating RGB information, the DT2871 color frame grabber lets a PC/AT perform color conversion in real time. The DT2871 can also convert HSI data back to an RGB image after processing.

The company offers the Aurora Subroutine Library for the DT2871; the library costs $995 and provides Pascal, C, and Fortran subroutines that permit color-image capture, processing, and display. It also lets you perform graphics operations, and it supports the functions of the $995 DT2869 video decoder/encoder, which the vendor offers as an accessory for the DT2871. The decoder/encoder reformats standard NTSC or PAL video signals from composite-video cameras and VCRs into RGB signals, and vice versa; its high analog precision preserves the digital integrity of the frame grabber's input and output.

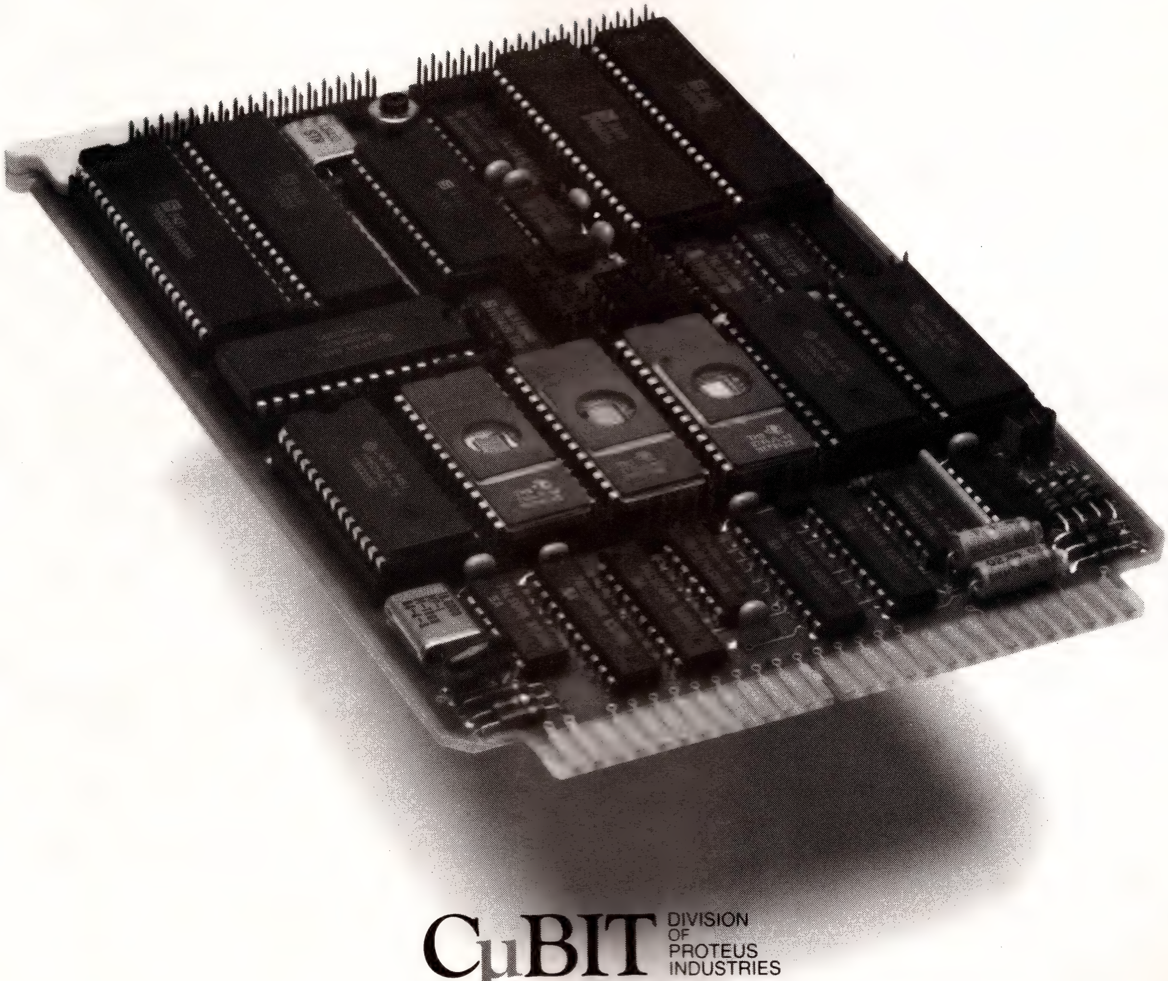
VME Bus provides standard

Datacube, maker of the MaxVideo line of image-processing boards, notes that its products adhere to the VME Bus double Eurocard form factor, ensuring electrical and mechanical compatibility with other vendors' boards. The MaxVideo family includes the DigiMax video-signal A/D and D/A converter, which accepts input from as many as eight cameras. The vendor's FrameStore board provides three 512×512-pixel×8-bit stores that you can configure as a single 16- or 24-bit-deep frame-storage device. The Snap board performs real-time, nonlinear systolic-neighborhood processing at 180 million 8-bit comparisons/sec. The Max-SP signal processor lets you merge multiple images, perform barrel shifting, and multiply. The VFIR linear pixel processor can perform 100 million 20-bit precision multiply-accumulation operations/sec.

For $1000, you can buy MaxWare version 2.0, a software support package that provides primitive and

CμBIT FOR 6502 ON STD BUS.

CMOS 6502
PERIPHERALS
SOFTWARE



CμBIT DIVISION OF PROTEUS INDUSTRIES

190 S. Whisman Road
Mountain View, CA 94041-1577
Telephone: (415) 962-8237

CIRCLE NO 127

diagnostic support for the aforementioned boards, as well as a number of other boards, including the ROIStore region-of-interest frame store, the MaxScan asynchronous digitizer module, the MaxMux digital crosspoint switch, and the MaxGraph graphics-overlay board.

Low-cost imaging available

As high-end products gain more sophistication and features, the technology trickles down to low-end systems, improving the capabilities of the inexpensive imaging packages available for such computers as the Atari ST and the Commodore 64. For example, Digital Vision Inc offers a $250 slow-scan image-capture program called ComputerEyes for the IBM PC, Apple II, Atari IIgs, Atari ST, Atari 8-bit computer, and Commodore 64. ComputerEyes requires a maximum of 12 sec to scan a single monochromatic image at a resolution of 640×200 pixels with 64 gray levels.

Besides offering simple digitizing, ComputerEyes also provides gray-scale, false color, and high contrast for the image. ComputerEyes supports CGA, EGA, VGA, and Hercules graphics modes. It lets you save an image to disk in a variety of formats so that programs such as Xerox's Ventura Publisher, Microsoft's Gem, and Aldus' PageMaker can access the image data and manipulate it. For $520, you can order ComputerEyes with a video camera, lens, and cable. A developer's package with source code and image-file formats costs $100. **EDN**

Article Interest Quotient
(Circle One)
High 518 Medium 519 Low 520

InterTools™
Time Saving Software
For Embedded System Development
68000/010/020, 8086/186/286
68HC11, Z80, V Series

C Cross Compilers
- Global Optimization Features
- Produce Re-entrant, ROM-able Code
- Utilities include Linkers, Locators, Formatters, and Unique ROM Processor

Cross Assemblers
- Full Macro Capabilities
- Include Complete Utilities Set
- Support Relocatable, Combinable, and Absolute Segments

XDB Cross Debuggers
- Debug at C or Assembly Source Code Level
- User-Friendly Interface and Command Set
- Powerful Assertion, Breakpoint Commands
- Direct Command Interface to Emulator

InterTools are available for VAX, SUN, Apollo, HP, IBM PC, and other engineering computers.

Demo Disks available.

Intermetrics, Inc.
Software Products Division
733 Concord Avenue
Cambridge, MA 02138
(617) 661-0072
Toll-Free: 1-800-356-3594

Intermetrics

CIRCLE NO 5

MULTIBUS II TAKES YOU BACK TO THE BASICS

. . . AND INTO THE FUT

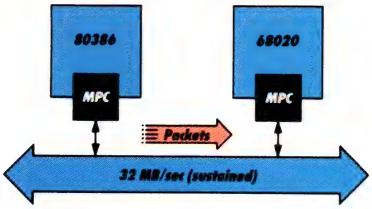
MULTIBUS II OPENS UP ADVANCED APPLICATIONS IN WAYS NO OTHER BUS CAN.

When the architects of Multibus II set out to create an advanced bus, they set their sights far beyond just another souped-up traditional bus.

They went back to the basics and created a truly *advanced* bus.

A bus capable of supporting vast new levels of microcomputer performance. To make possible low cost microcomputer systems that outperform minis, and rival mainframes.

An inherently more reliable bus, suitable for applications that process huge volumes of data at unprecedented speeds.



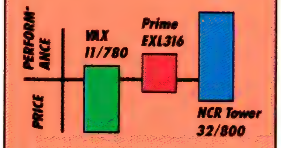
BASIC #2: HARDWARE-ASSISTED MESSAGE PASSING.
This advanced technique gives Multibus II a true sustained bandwidth of 32 megabytes per second. Standardized in a single silicon chip, message passing simplifies sytem design, and makes it possible to mix totally different microprocessor architectures and operating systems in the same application.

A more maintainable bus, to reduce the cost and complexity of configuration, trouble-shooting and repair.

A bus solid enough to gain the support of a broad base of hardware and software vendors, and ensure that all products would work together efficiently and dependably.

It would be the ideal advanced bus—the perfect higher performance alternative to Multibus I, VME and other traditional architectures.

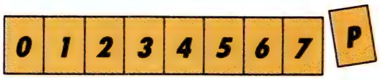
PRICE/PERFORMANCE:
A new generation of microcomputer systems based on Multibus II is now emerging, to redefine standards of price and performance.



MULTIBUS II IS CHANGING THE WORLD!

The advanced bus of the future is here today, to the delight of designers needing to transcend the limitations of today's other bus alternatives.

BASIC #3: AUTO CONFIGURATION.
Like a chameleon, Multibus II boards automatically configure themselves when system power is turned on, eliminating DIP switch hassles during configuration and maintenance.



BASIC #1: PARITY.
Multibus II's parity error detection provides the basic protection needed by advanced applications that process large volumes of data at high speeds.

For example, NCR and Prime based their newest Tower™ and EXL™ systems on Multibus II. Both provide several times the power of a VAX™ 11/780 minicomputer, at a fraction of the price.

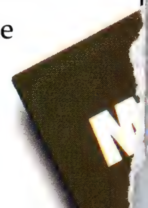
TRADITIONAL VS. A

	CHARACTERISTICS	TRADITIO
		MULTIBUS I
BASIC FEATURES	TIMING (Synchronous or Asynch)	ASYNCH
	PIN USAGE (MPX) Multiplexed (NON) Non-Multiplexed	NON
	ARBITRATION (CENT)ralized (DIST)ributed	CENT.
	INTERRUPTS (DED)icated (VIR)tual	DED.
	GLOBAL MEMORY Communications	YES
ADVANCED FEATURES	PARITY	NO
	AUTO-CONFIGURATION (Geographic Addresses)	NO
	MESSAGE PASSING (Hardware)	NO
	BUS I/F SILICON	NO
OTHER FEATURES	ADDRESS WIDTH (Bits)	20,24
	DATA WIDTH	8,16
	BOARD AREA (sq. in.)	84
	CONNECTOR TYPE	EDGE
	MAX. 5V POWER (Per slot)	24A

**Implemented outside IEEE 1014 using several proprietary schemes.*

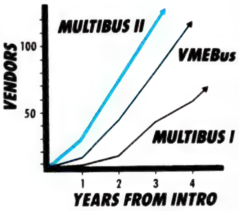
A major U.S. department store chain has put into operation a revolutionary home shopping network, based on Multibus II.

In Europe, Multibus II was chosen by a leading automation company as its



RE.

architecture for the future for advanced factory automation applications.



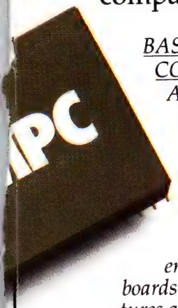
MULTIBUS II:
The world's fastest growing open system architecture!

And two leading aerospace companies are using Multibus II to build the world's most advanced aircraft flight simulators.

VANCED ARCHITECTURES

AL BUSES	ADVANCED BUSES	
VME	MULTIBUS II	VAX BI
ASYNCH	SYNCH	SYNCH
NON	MPX	MPX
CENT.	DIST.	DIST.
DED.	VIR.	VIR
YES	YES	YES
NO	YES	YES
NO	YES	YES
NO*	YES	YES
AVAIL. '88	YES	YES
24,32	32	32
8,16,24,32	8,16,24,32	8,16,24,32
59.8	80	73.4
DIN	DIN	ZIF
6A	15A	Not Published

Throughout the world, these and scores of other companies have introduced or are now developing Multibus II applications that set new standards of performance, price and reliability.

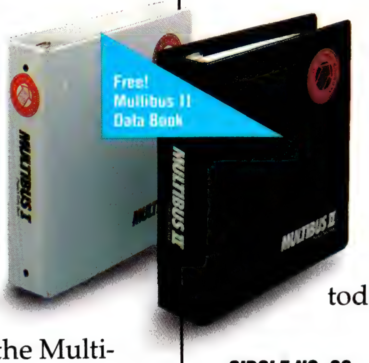


BASIC #4: MULTI-VENDOR COMPATIBILITY.
A host of unique features ensure that Multibus II boards will work together efficiently and dependably. The IEEE 1296 specification is complete and concise. And, the Multibus II Message Passing Coprocessor (MPC), now universally available, ensures compatibility even between boards using different processor architectures and operating system software.

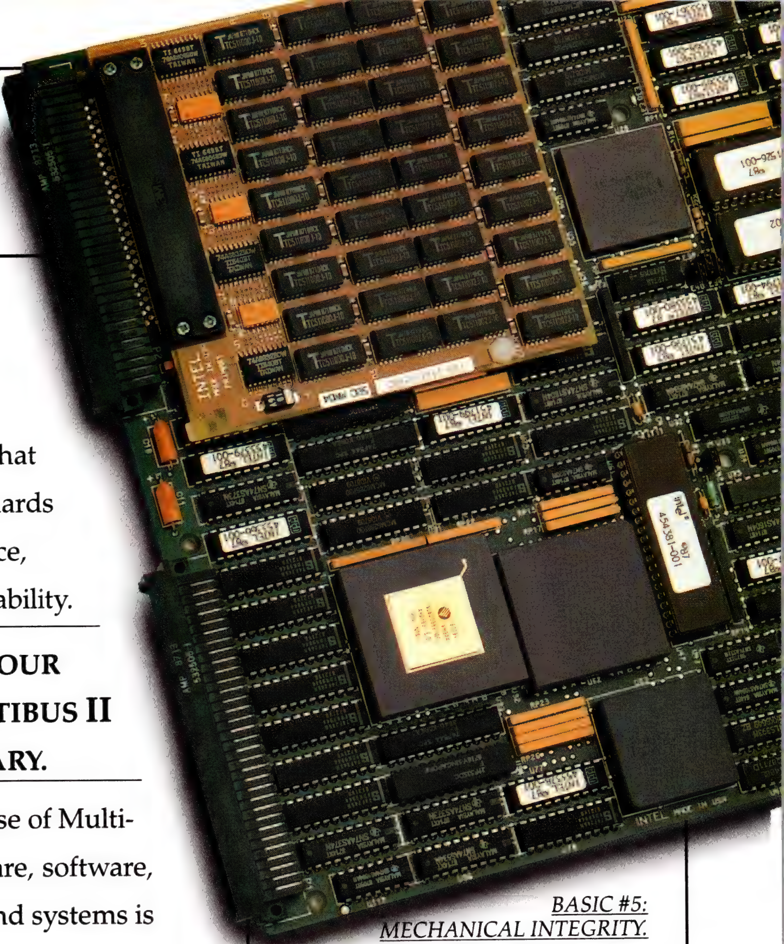
BUILD YOUR OWN MULTIBUS II LIBRARY.

The broad base of Multibus II hardware, software, accessories and systems is growing almost daily. Yet it's easy for you to keep up to date.

Just circle the reader service number, and each of the companies on the back of this ad will send you in-depth technical data on their complete Multibus II product lines. Plus timely updates and new product announcements.



And, to keep your Multibus II library organized, the Multibus Manufacturers Group will send you this convenient indexed bookshelf binder. Absolutely free!



BASIC #5: MECHANICAL INTEGRITY.
Naturally, Multibus II uses DIN connectors, for the most reliable mechanical connections. But, it also incorporates built-in front panels for EMI shielding. And, its standard Eurocard form factor provides enough board space (a full 80 sq. in.) to accommodate complex designs.

So don't delay. Get the whole story on Multibus II and discover the new levels of performance and reliability that are possible with a truly advanced bus.

Multibus II.

The bus of *your* future is here today.

CIRCLE NO. 99

MULTIBUS MANUFACTURERS GROUP

P.O. Box 6208 Aloha, OR 97007 (503) 629-8497

Multibus® is a trademark of Intel Corp.
EXL™ is a trademark of Prime Computer Inc.
Tower™ is a trademark of NCR Corp.
VAX™ is a trademark of Digital Equipment Corp.

WE'RE HERE FOR YOU!

The companies listed below would like you to know that Multibus II is now in full swing. These industry leaders offer a complete selection of Multibus II boards, software, systems and accessories—everything you need to develop advanced, high performance applications today.

For your free Multibus II Data Book plus future new product announcements, just return the reader service card. Or, for faster response, call the MMG or one of the participating companies listed below.

Discover what the world's most advanced OEM microcomputer bus can do for *your* next generation applications.

	CPUs	Digital I/O	Analog I/O	Special I/O	Periph Cont	Comm/Net	Graphics	Memory	Software	Packaging	Systems
AUGAT										•	
intel	•	•	•		•	•	•	•	•	•	•
Central Data	•	•		•	•	•			•		
INTERPHASE corporation					•	•					
CIPRICO					•						
MICROBAR SYSTEMS, INC.	•			•		•			•		•
concurrent technologies	•	•	•			•					
MUPAC										•	
DIGITAL RESEARCH									•		
SCANBE										•	
Electronic Solutions								•		•	
SYSTECH						•					

AUGAT®
P.O. Box 1037
Attleboro, MA 02703
Contact: Dept. X2403
(617) 222-2202
FAX (617) 226-5257

intel®
Intel Corporation
3065 Bowers Avenue
Santa Clara, CA 95051
(800) 548-4725

Central Data
1602 Newton Drive
Champaign, IL 61821
Contact: André Felix
(800) 482-0315
FAX (217) 359-6904

INTERPHASE corporation
2925 Merrell Road
Dallas, TX 75229
Contact: Sales Admin.
(214) 350-9000
FAX (214) 350-1433

CIPRICO
2955 Xenium Lane
Plymouth, MN 55441
Contact: Don Peterson
(612) 559-2034
FAX (612) 559-8799

MICROBAR SYSTEMS, INC.
785 Lucerne Drive
Sunnyvale, CA 94086
Contact: Bill Burton
Telephone (408) 720-9300
FAX (408) 773-9475

concurrent technologies
25401 Cabot Road, Suite 206
Laguna Hills, CA 92653
Contact: Robert McAuley
(714) 768-3332
FAX (714) 951-8902

MUPAC®
10 Mupac Drive
Brockton, MA 02401
Contact: Steve Cobb
(617) 588-6110
FAX (617) 588-0498

DIGITAL RESEARCH
60 Garden Court, Box DRI
Monterey, CA 93942
Contact: Customer Service
(800) 443-4200
Telex 910-360-5001

ZERO SCANBE
UNIT OF ZERO CORPORATION
3445 Fletcher Avenue
El Monte, CA 91731
Contact: Mike Burton
(800) 227-0557
FAX (818) 444-3953

ZERO Electronic Solutions
UNIT OF ZERO CORPORATION
6790 Flanders Drive
San Diego, CA 92121
Contact: Frank Hom
(800) 854-7086
In CA: (800)772-7086

SYSTECH
6465 Nancy Ridge Drive
San Diego, CA 92121
Contact: Trevor Constable
(619) 453-8970

The Multibus Manufacturers Group, or MMG, is dedicated to the proposition that everyone benefits from strong, open standards. Membership is open to hardware and software manufacturers, application integrators, end users and even students.

To learn more about what the MMG can do for you, contact Dan Fink, MMG executive director.

Use this convenient product reference guide to quickly locate the companies that offer the types of Multibus II products you need.

CIRCLE NO. 99

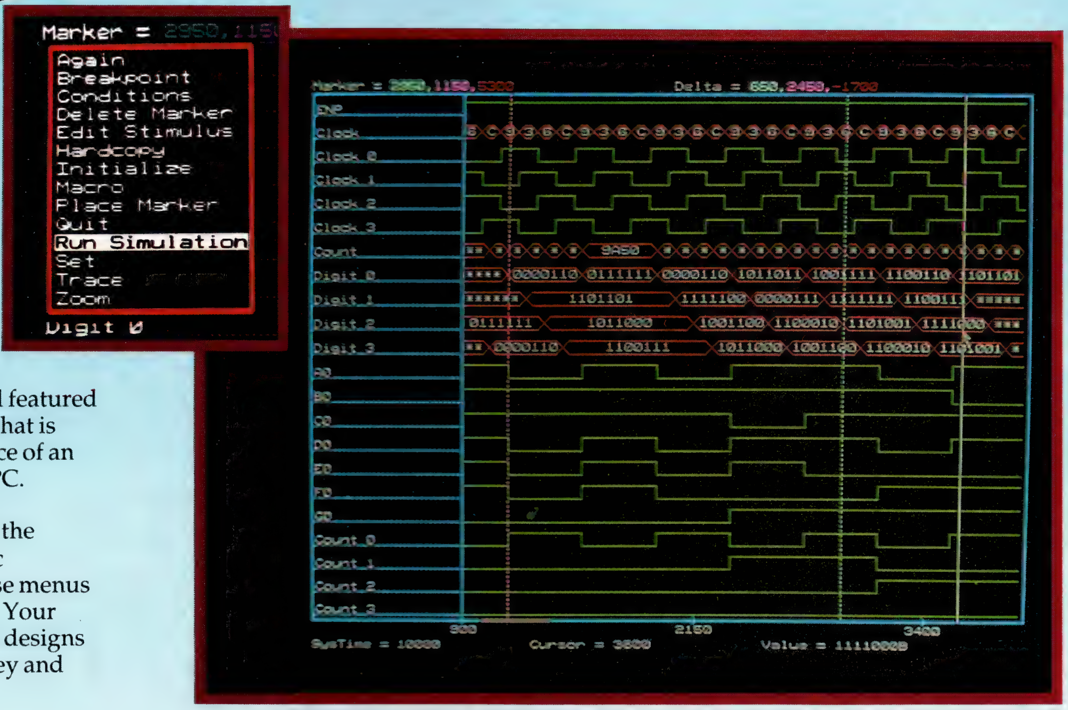
©Copyright 1988 Multibus Manufacturers Group

MULTIBUS MANUFACTURERS GROUP
P.O. Box 6208 Aloha, OR 97007 (503) 629-8497

MULTIBUS MANUFACTURERS GROUP

Introducing OrCAD Verification and Simulation Tools

Logic Simulation



Easy to use menu driven commands speed and simplify design verification.

OrCAD / VST

The Next Logical Step

Introducing OrCAD / VST, a full featured verification and simulation tool that is designed to place the performance of an expensive workstation on your PC.

OrCAD / VST is integrated with the popular OrCAD /SDT schematic capture package, with easy-to-use menus and powerful keyboard macros. Your valuable time is used to simulate designs without investing the time, money and resources to built prototypes.

With unsurpassed performance on a PC, you'll discover that nothing comes close to OrCAD's features and price. Benchmark the specifications for yourself. We guarantee satisfaction, or your money back!

- Event driven, 12-state functional simulator
- Exceeds 10,000 events/sec. on an 8 MHz AT without additional hardware
- Over 14,000 gate capacity
- Logic analyzer display format. Virtual screen displays 50 channels
- 10 breakpoints can be set as AND/OR condition of up to 16 signals
- User selectable minimum and maximum delays
- Input stimulus is easily defined with an integrated pop-up editor
- Includes component models of TTL, ECL, CMOS, Memory devices, and easy to use utility for creating custom models
- Of course, OrCAD's excellent support: technical staff to answer questions, 1 year of free product updates, and a trained sales and support network

Call or write today for our Demo Disk and brochure.

OrCAD™
Systems Corporation

1049 S.W. BASELINE ST. SUITE 500
HILLSBORO, OREGON 97123, USA
(503) 640-5007

Contact your local OrCAD Representative for further information

AUSTRALIA
Prometheus
0 3819 6088

AUSTRIA
Dahms Elektronik Gmbh
0 316-640300

DENMARK
Supersoft
817-3065

ENGLAND
ARS Microsystems, Ltd.
(0276) 685005

FINLAND
Elektrotel OY
754-3122

FRANCE
ALS Design
(04) 6043047

ITALY
BRM Italiana
(011) 287884

JAPAN
Sotec Company, Ltd.
045 (641) 0802

BENELUX
Post Electronics, NL
02159 - 41774

SPAIN
Next-Fors
(0) 261-2415

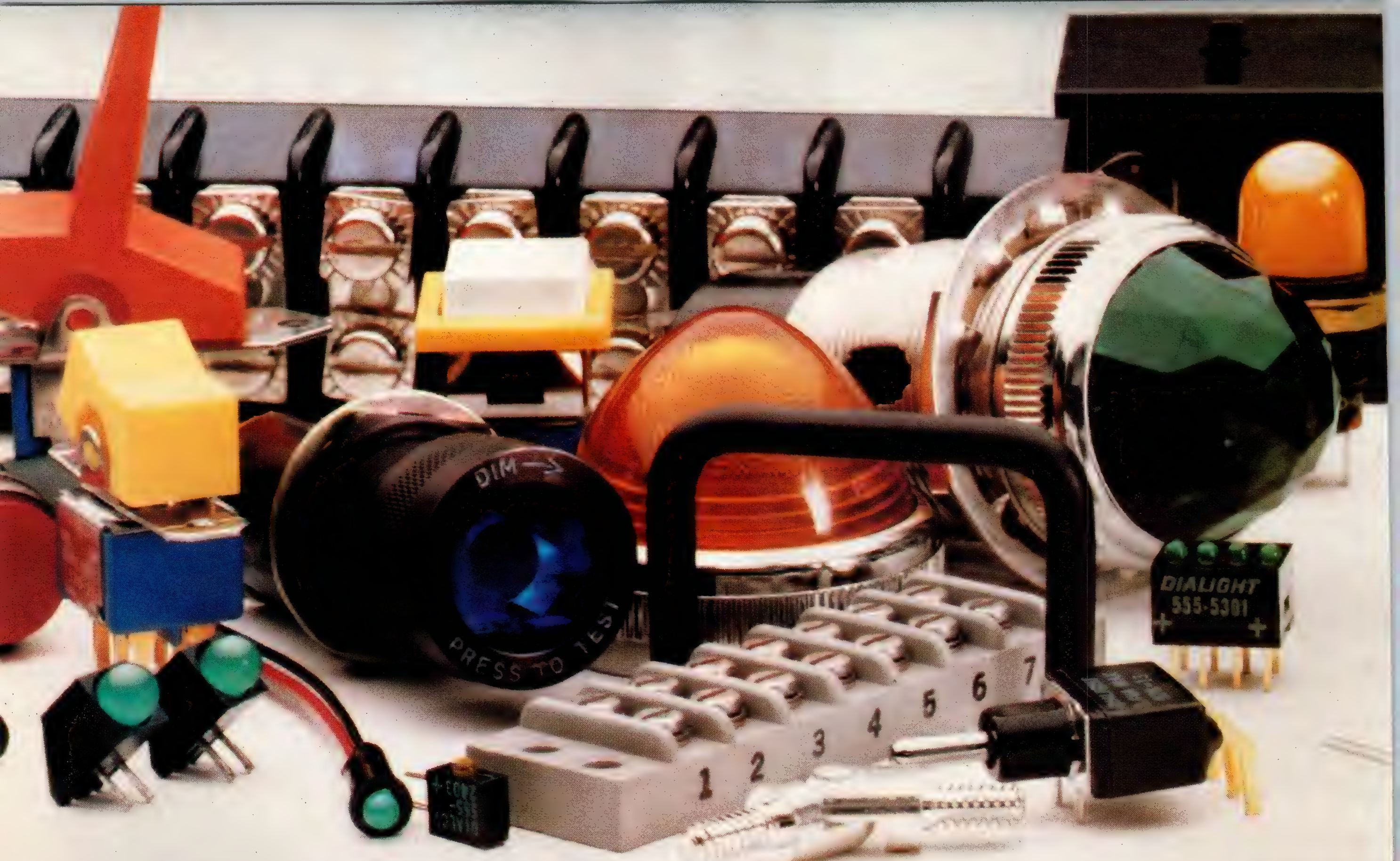
SWEDEN
Technology Partners
0 8-156815

SWITZERLAND
Logmatic AG
056 83 38 38

WEST GERMANY
Compware Gmbh
040 - 818074

OR 8746-A

CIRCLE NO 166



Engineering is the only

It's widely held that if you've seen one LED, you've seen them all. The same goes for things like terminal blocks and switches. A myth at times perpetuated by the very companies that make and market these products. With one notable exception.

Dialight Company.

Passive components, actively engineered.

We believe that passive components are no less important than integrated circuits. An attitude that's reflected in the way we go about our work.

Our design team is constantly assessing the manufacturing techniques of OEMs in every important technology. Anticipating ways to make our products easier and more economical to design-in and install (our invention, the Circuit Board Indicator is a good example).

They'll spend months developing a new compound for our sealed switches. Or devising a reliable way of testing each and every one of our Circuit Board Indicators and LEDs. They'll lose sleep over milliohms of contact resistance, or a fraction of an inch clearance on our switch terminals.

It's an attitude that's ultimately reflected in the products we sell.

Dialight Circuit Board Indicators

A product concept we pioneered over fifteen years ago to facilitate fast, reliable circuit board installation of LEDs, the Dialight Circuit Board Indicator is designed to insert and wave solder in up to one fourth the time at up to one fourth the cost of non-packaged LEDs.

All 100% tested and available in hundreds of standard and custom designs including the latest super-bright gallium aluminum arsenide units.

Dialight Indicator Lights

No one makes more indicator lights for more applications than Dialight. Over a million designs accrued through fifty years of innovation. Incandescent, neon and LED units available in commercial and even the latest military configurations to meet MIL-L-85762A night vision requirements.

Dialight Switches

More than 100,000 designs that include illuminated pushbuttons, rockers, toggles and levers in a wide range of terminations, contact

commodity we sell.

ratings and mounting styles. All 100% tested. All customized to meet any application need.

Even sealed switches specifically engineered for board-mounted solvent washing with sealed O-rings to prevent seepage.

Kulka Terminal Blocks

Molded from special aggregates that in some models, withstand temperatures in excess of 155°C. Making Kulka the only manufacturer to meet B, F and HT requirements of MIL-T-55164C.

Standard features include solid brass, nickel-plated screws, molded-in contacts and special plates that prevent overtorquing and breakage. All readily engineered into any conceivable custom or special order.

HHSmith Hardware

Spacers, stand-offs, handles, knobs and other components all available in an extremely wide variety of sizes, configurations, and materials, as well as thread and finish specifications to meet any and every requirement. From the most basic and cost-sensitive to the most demanding Mil-spec applications.

Dialight, Kulka and HHSmith products that speak of rigorous quality control, exhaustive testing and the Company philosophy of design and engineering: the word passive may be used to describe our components, but never the way we build them.

Find out more about Dialight LEDs, Circuit Board Indicators, Indicator Lights, Switches, Kulka Terminal Blocks and HHSmith Components. Call us at 201-223-9400, or write Dialight Company, 1913 Atlantic Ave., Manasquan, NJ 08736, and ask for a free catalog today.

DIALIGHT COMPANY A Division of North American Philips

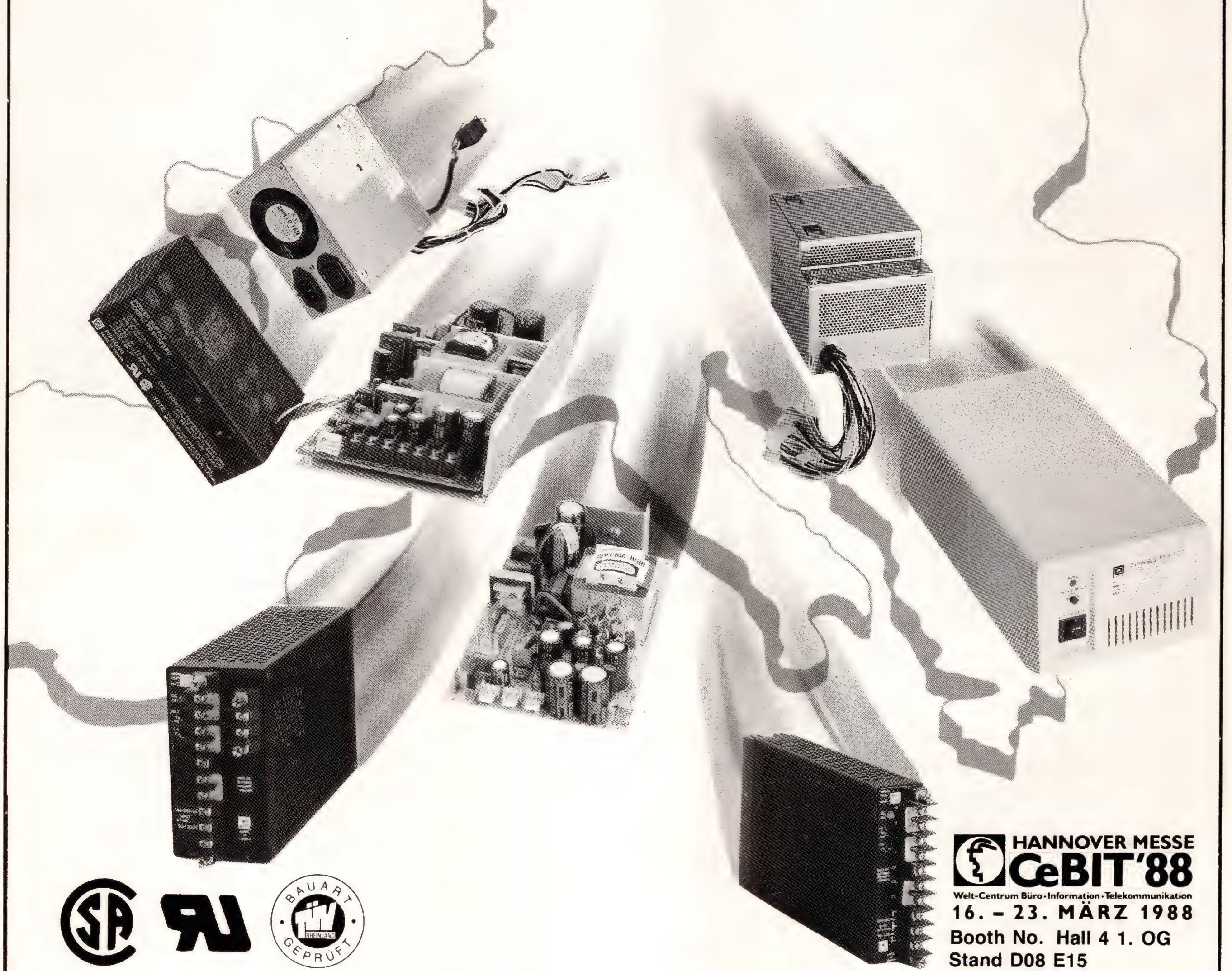
SEE US AT ELECTRO/'88, BOSTON, MAY 10-12, BOOTHS 1342-48

DIALIGHT·KULKA·HHSMITH

Engineering is the only commodity we sell.

CIRCLE NO 165

Your unlimited power partner-PHIHONG



HANNOVER MESSE
CeBIT'88
Welt-Centrum Büro · Information · Telekommunikation
16. – 23. MÄRZ 1988
Booth No. Hall 4 1. OG
Stand D08 E15

BAUART GEPRÜFT
RHEINLAND

PHIHONG's 16 years of experience in development & design of continuous power, power supplies, gives its customers an unequalled advantage in meeting their needs switching power supplies, ranging 15 to 300 watts, are available in a variety of styles and are UL CSA and TUV approved. What makes all this possible is the avanced technology and high quality people and materials available. Next time your need power, we'll be glad to assist.

PHIHONG

PHIHONG ENTERPRISE CO., LTD.
TAIWAN PLANT: 27-12 TAYU ST.,
SANCHUNG CITY, TAIPEI, TAIWAN, R.O.C.
TELEX: 31182 PHIHONG PHONE: (02) 988-2126
FAX: 886-2-9817086

PHIHONG U. S. A. INC.
240 LOS GATOS BLVD LOS GATOS, CA95032
TEL: (408)395-9222 FAX: (408) 395-3075

Advances in speed and voltage ratings enhance applications for optocouplers

Dave Pryce, *Associate Editor*

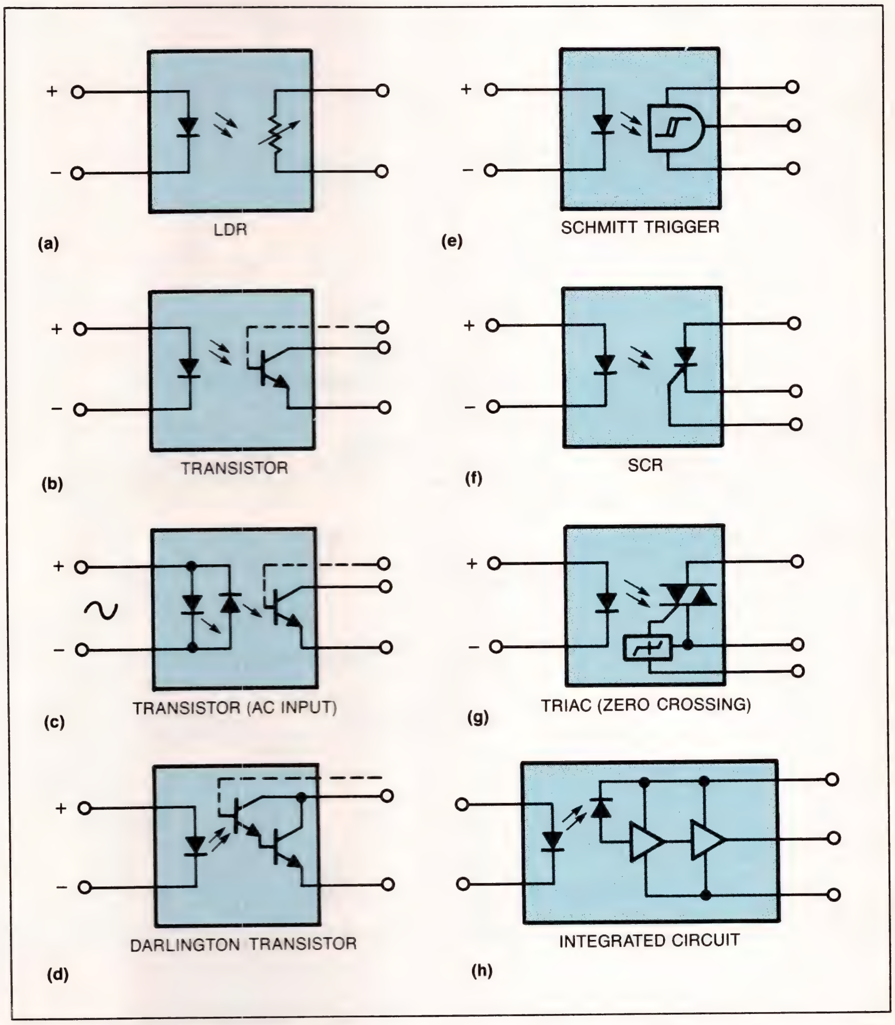


Fig 1—Optocouplers come in a wide variety of types. *The primary differences show up in the output stages, which include, but are not limited to, the types depicted here.*

The widespread use of optocouplers is testimony not only to their long history, but to the great variety of types for sale. Optocouplers are available in several possible output configurations, including LDRs (light-dependent resistors), various transistor types, logic elements, and SCRs and triacs (bidirectional triode thyristors) **(Fig 1)**.

From factory-floor networks to missiles and satellites, the use of optocouplers to provide isolation between different environments continues to increase. You'll find the devices suitable for such diverse applications as motor controls, process controls, power supplies, data transmission, CD players, VCRs, and telecommunications equipment.

It all starts with the emitter

Key to the operation of an optocoupler is the emitter (normally an LED), which generates the light energy, and the silicon detector, which is the photosensitive output device. In the case of optocouplers, the light energy from the emitter is usually in the infrared or near-infrared portion of the spectrum. Emitters are fabricated in either GaAs, GaAsP, or GaAlAs, depending on the intended application of the optocoupler and certain cost/performance tradeoffs determined by the manufacturer.

Motorola, for example, uses three different emitters in its optoelectronic products **(Fig 2)**:

- 660-nm (visible light) GaAlAs
- 850-nm (near infrared) GaAlAs
- 940-nm (infrared) GaAs.

Although the 940-nm GaAs emitter's spectral emission is not perfectly matched to the response of a silicon detector, Motorola uses this emitter in most of its optocouplers for reasons of cost effectiveness. Most general-purpose applications can tolerate a certain amount of spectral mismatch, and the resulting lower cost of the optocoupler justifies the use of such an emitter.

The 850-nm GaAlAs emitter's peak emission does closely match the response of a silicon detector, and Motorola uses this emitter in optocouplers designed for applications where high efficiency and fast speed are important.

The 660-nm GaAlAs emitter is poorly matched to the response of a silicon detector, and for this reason Motorola doesn't use it in any of its optocouplers. (This type of emitter is ideal for use in other optoelectronic products, however—in plastic fiber-optic communications systems, for example. At 660 nm, the attenuation curve of plastic fiber is near its minimum value.)

Other manufacturers take similar

Bench & Systems power supplies...

Farnell has been manufacturing bench power supplies since 1958.

Thirty years of leadership in the market has ensured widespread use of Farnell power units. For example, there are in excess of 100,000 L series in technical colleges, universities, research laboratories and service departments around the world. Several Farnell power supplies have NATO stock numbers. The 21.000m^2 production facility is UK Defence Standard AQAP4 registered, and the Company has wide experience of manufacturing to IEC, VDE, BS, UL, CSA and other standards. Quality and good value are integral components of every Farnell power supply.

Sales and support offices are located in more than sixty countries. These agent/distributers are qualified to help you select, use and maintain your Farnell bench power supply. European agents are listed below. Why not telephone your nearest one now for detailed information?

... from Farnell

Sixteen page
colour catalogue
will be mailed
if you respond
to this advertisement.

Farnell

FARNELL INTERNATIONAL · WETHERBY · LS22 4DH · UK
INT. TEL. +44 937 61961 · FAX +44 937 66487
TELEX 55478 FARINT G

European Agents:

AUSTRIA
Ing Otto Folger (Wien)
Tel. 02 22 42 51 21

BELGIUM
Heynen n.v. (Hasselt)
Tel. 011 21 00 06

DENMARK
ITT (Glostrup)
Tel. 02 45 18 22
Buch Electronics APS (Brondby)
Tel. 02 96 40 70

EASTERN EUROPE
via Tectra AG (Zürich)
Tel. 055 95 12 13

FINLAND
Finlandia Interface Oy (Espoo)
Tel. 90 803 7266

FRANCE
Etabs Mesureur (Paris)
Tel. 014 583 66 44

WEST GERMANY
Cosmos Powerline (München)
Tel. 089 311 9921

GREECE
M. J. Priniotakis
Electrochemicals SA (Athens)
Tel. 727 719

NORTHERN IRELAND
Imex Systems Ltd (Co. Down)
Tel. 0238 511095

EIRE
Imex Systems Ltd (Co. Louth)
Tel. 353 42 72282

ITALY
Farnell Italia s.r.l. (Merate)
Tel. 039 597612

NETHERLANDS
Koning en Hartman (Delft)
Tel. 015 609906

NORWAY
Feiring Elektronikk A/S (Oslo)
Tel. 02 649070

PORTUGAL
Digital Tecnica (Quelez)
Tel. 1 437 9517

SPAIN
Hannovan Electronica SA
(Madrid)
Tel. 413 80 99

SWEDEN
Scancopter AB (Stockholm)
Tel. 08 761 78 20

SWITZERLAND
Dr. K. Witmer Elektronik
(Erlenbach)
Tel. 01 915 15 53

CIRCLE NO 176

approaches in their selection of LEDs for use as emitters in optocouplers. Philips in The Netherlands, for example, (along with its subsidiary in the US, Amperex Electronic Corp), uses GaAlAs emitters with wavelengths of 830 nm and 740 nm. Philips uses the 830-nm emitter with photodiodes and phototransistors whose peak sensitivity is between 800 and 850 nm; it uses the 740-nm emitter with integrated photoreceivers whose peak sensitivity is between 700 and 750 nm.

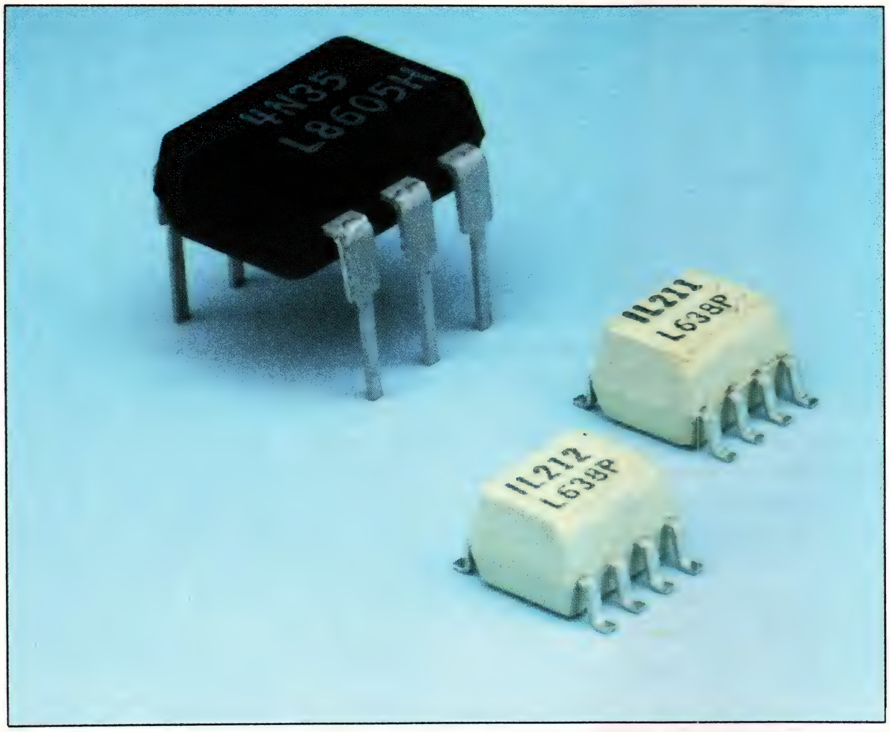
Curiouser and curiouser

Hewlett-Packard chooses to use an 820-nm GaAlAs emitter for many of its high-speed optocouplers. Curiously, HP reverses the order of the first two chemical symbols and lists the emitter material as AlGaAs.

Although many companies use GaAs and GaAsP emitters, the trend is to GaAlAs. The reason for this increase in use is because manufacturers can alter the bandgap of GaAlAs emitters to produce radiation at any desired wavelength between 650 and 900 nm. It is the gallium/aluminum ratio that determines the bandgap. Another advantage of GaAlAs emitters are their generally lower drive-current requirements, which makes them a better choice for use in optocouplers that interface with CMOS ICs.

Most manufacturers of GaAlAs emitters use a homojunction technology having a single bandgap. Philips and Amperex, however, use a single-heterojunction technology that has two epitaxial layers with different bandgaps. Philips claims that using this structure significantly lessens the degradation (over time) of the emitters' current-transfer ratio (CTR).

Compared with emitters, photodetectors don't present as many choices—or as many problems. Silicon detectors have a wide spectral response that extends from 700 to 950 nm, with a broad, flat peak between 750 and 900 nm. And, be-



Optocouplers often come in 6- and 8-pin DIPs, *but some types are now available in SOIC (small-outline integrated-circuit) or other surface-mount packages. These types from Siemens are representative.*

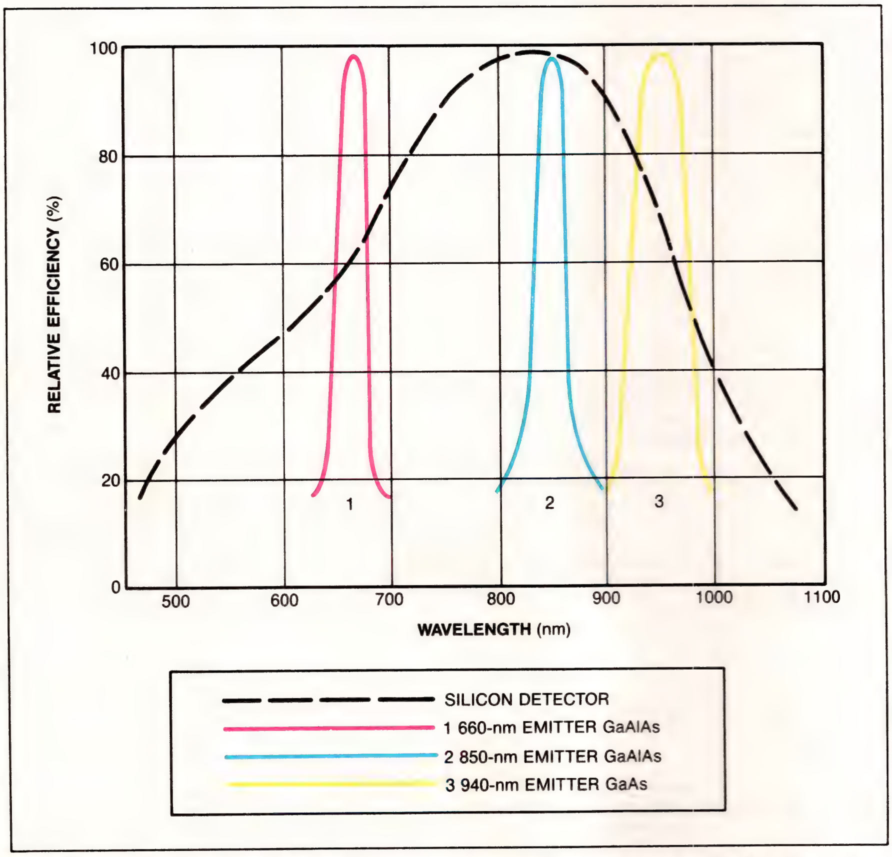


Fig 2—Optocoupler emitters are usually made from materials such as GaAs, GaAsP, and GaAlAs. *Application-dependent factors such as efficiency and the wavelength of the emitter's spectral emission determine which type a manufacturer selects. Fortunately, a silicon detector can accept a wide range of emitted wavelengths.*

cause of this wide response, they accommodate a wide range of emitter wavelengths.

Because of the choice of materials, structures, and output configurations available, optocouplers satisfy the isolation requirements of a variety of applications. One such application example uses the LDA200 dual-channel, current-monitoring switch from Theta-J Corp. The $2.75 (100) LDA200 is useful in industrial applications for input-to-output isolation and control-system monitoring, but its principal use is in telecommunication circuits **(Fig 3)**. In this application, the optocoupler provides ring-current sensing and loop-current detection.

The LDA200 allows the circuit designer to select the actual in-circuit trigger point for the loop current by choosing an appropriate value for the input shunt resistor. Without a shunt resistor, the LDA200 remains off for loop currents of less than 5 μA and turns on for loop currents of greater than 6 mA. A shunt resistor of 120Ω provides loop detection at 16 mA, but rejects loop noise currents of less than 6 mA without false triggering. The other channel of the optocoupler acts in a similar manner to detect the presence of a ring signal.

The optocoupler's output devices are open-collector bipolar transistors rated at 20V. Normally, you use an output-load resistor to limit the on-state current in the transistor so as not to exceed a steady-state dissipation of 150 mW per transistor, or 400 mW for the entire package. You have a choice of an 8-pin DIP or a surface-mountable version.

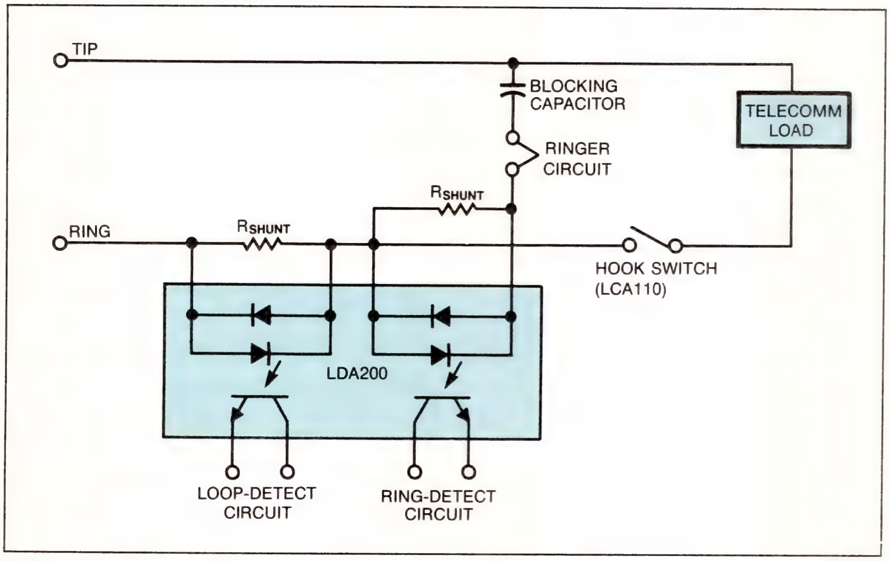


*Fig 3—**In this telecommunications application,** the LDA200 optocoupler from Theta-J monitors the line to detect the presence of loop current and a ring signal.*

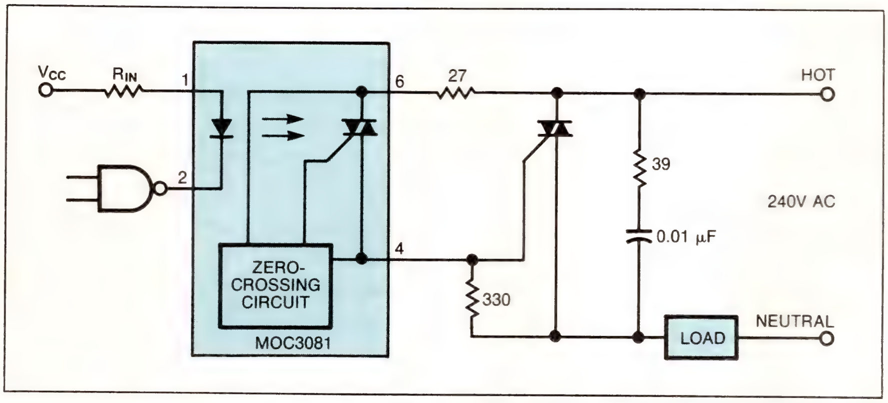


*Fig 4—**Optocouplers are commonly used to isolate high voltages from sensitive input circuits.** This triac-output type from Motorola switches power to a load connected to a 240V ac line. The MOC3081's blocking-voltage rating is 800V.*

Traditional uses still remain

One of the traditional applications for optocouplers is the isolation of low-voltage circuits from high-voltage circuits, particularly when switching the hot side of an ac line. Not only do the MOC3081, MOC3082, and MOC3083 optoisolators from Motorola perform this function for line voltages to 240V ac, but they feature a high isolation-voltage rating of 7500V (min) and an output driver (triac) with a blocking-voltage rating of 800V. The devices are useful in the interface of logic systems to motors, solenoids, industrial controls, and consumer appliances.

Each of the devices comes in a 6-pin DIP and includes a GaAs infrared LED and a monolithic silicon chip consisting of a detector, a triac driver, and zero-crossing circuitry. The only difference between the three optocouplers is in the LED trigger-current required to latch the output—the MOC3081 is rated at 15 mA, the MOC3082 at 10 mA, and the MOC3083 at 5 mA. Prices differ accordingly: MOC3081, $1.81; MOC3082, $2.11; and MOC3083, $2.45 (100).

Fig 4 shows a typical MC3081 configuration for switching power to a load that is connected to a 240V ac line. The external triac switches the hot side of the line, and the load terminates in the neutral (cold) side of the line. You can, however, connect the load to either side of the line. You calculate resistor R_{IN} to provide the rated LED trigger current of the device. The 39Ω resistor and the 0.01-μF capacitor are included for purposes of snubbing the triac, and they may not be necessary for certain triac-load combinations.

Siemens Components also offers a

ALUMINUM CITY.

4SE-8101

SPRAGUE...A FULL LINE OF ALUMINUM CAPS FROM A U.S. SOURCE.

You can get any type of aluminum electrolytic capacitor that you need for *all* your applications from Sprague, the only U.S. based manufacturer of a complete line of high-performance aluminums. Whether it's axial-lead or single-ended miniature tubulars or large cans packed with capacitance, Sprague has the aluminum cap that'll meet your requirements. If you need radial or axial-lead miniatures for general purpose, power supply, special applications, or high-reliability military applications, we've got the capacitor you need. We offer all types of large cans for high-voltage SMPS input applications and low-voltage SMPS output use. And the best news of all...we can deliver fast because our aluminum cap line is available from Sprague plants in Lansing, NC and Hillsville, VA. For technical information, write for our new "Quick Guide To Aluminum Electrolytic Capacitors", ASP-502E, to Technical Literature Service, Sprague Electric Company, P.O. Box 9102, Mansfield, MA 02048-9102.

CIRCLE NO 164

SPRAGUE®
THE MARK OF RELIABILITY

device similar to members of the MOC3081 Series. The IL410 is a triac optocoupler with a zero-crossing detector circuit, but its internal circuitry is somewhat different. The output chip integrates a photosensitive npn transistor and a MOSFET with a triac driver. The addition of the MOSFET interface reduces the light output required from the emitter to drive the triac, thus providing an input sensitivity of 2 mA. The optocoupler has an isolation-voltage rating of 7500V, and the triac output stage has a blocking-voltage rating of 600V. Like the MOC3081 Series, the IL410 comes in a 6-pin DIP. It costs $1.95 (1000).

High-speed types are available

In addition to the optocouplers' improvements in voltage ratings, the development of high-speed devices is also advancing. Until comparatively recently, optocouplers were not known for their blinding speed. Over the past few years, however, companies like Hewlett Packard have been instrumental in changing this situation.

The HCPL-2400 logic-gate optocoupler is a good example. Designed for use in high-speed logic systems, computer-peripheral interfaces, switching power supplies, and digital isolation of ADCs and DACs, it provides a typical data-transfer rate of 20M baud. Depending on operating conditions, the device is capable of achieving speeds as high as 40M baud.

It also has high common-mode transient immunity and provides a logic-compatible output and, in contrast to a transformer, it offers dc as well as ac performance. The HCPL-2400 comes in an 8-pin DIP and costs $4.65 (100).

In a typical application circuit (**Fig 5**), the HCPL-2400 uses the fast current-switching capabilities of Schottky TTL logic (74STTL) to attain the 20M-baud data-transfer rate. The 74S04 totem-pole driver sources current to drive the input of the HCPL-2400 optocoupler in series. The 348Ω resistor limits current to the emitter, and the 30-pF capacitor assists in speeding up the emitter's turn-on and turn-off times.

At the output side, the optocoupler, which does not require a pullup resistor, directly drives the logic element. If desired, you can substitute a noninverting buffer at either the input or the output to change the circuit's function.

Of course, fast is relative

Although not nearly as fast as the Hewlett Packard device, the industry-standard 6N135 and 6N136 (**Fig 6**) nevertheless qualify as high-speed types. They have a bandwidth of 2 MHz and a typical switching speed of 1M bps. Each device contains a GaAsP emitter and an integrated photon detector comprising a photodiode and an open-collector output transistor. Separate connections for the photodiode bias current and the collector output of the transistor reduces the base-to-collector capacitance of the output transistor. This arrangement results in speeds as much as 100 times that of a conventional phototransistor.

The UL-registered optocouplers are designed for analog- and digital-interface applications in appliances, vending machines, facsimile machines, character readers, and telephones. In particular, the 6N135 is designed for TTL/CMOS, TTL/LSTTL, and wideband analog applications; the 6N136 suits high-speed TTL.

The devices (along with other family members 6N137, 6N138, and 6N139) are available from a number of suppliers, including Texas Instruments, General Electric, General Instrument, and Hewlett Packard. They are enclosed in 8-pin plastic DIPs and vary in price from $2.50 to $3 (100).

One of the earliest types of optocouplers used an LDR as the detector element. These types are still in wide use as feedback elements in automatic gain control (AGC) circuits, and in other applications where isolated control of a variable resistance is necessary. The CLM51

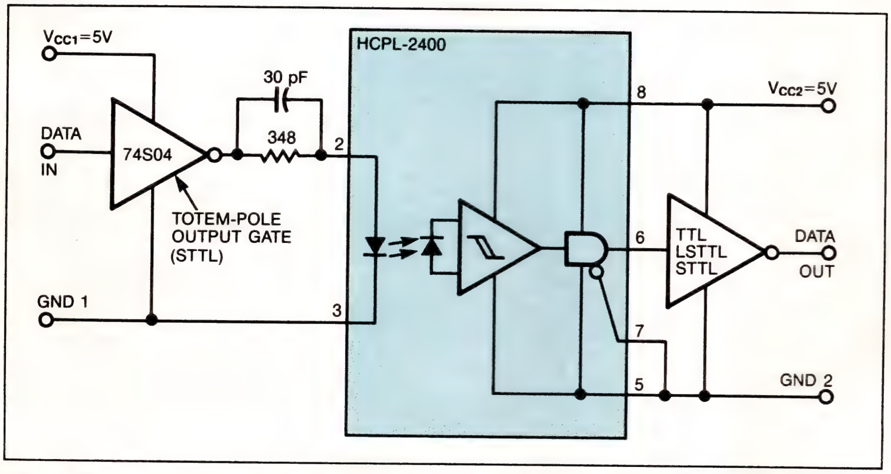


Fig 5—Designed for use in high-speed logic systems and computer-peripheral interfaces, *the HCPL-2400 from Hewlett Packard has a typical data-transfer capability of 20M baud. Depending on operating conditions, the device can achieve speeds as high as 40M baud.*

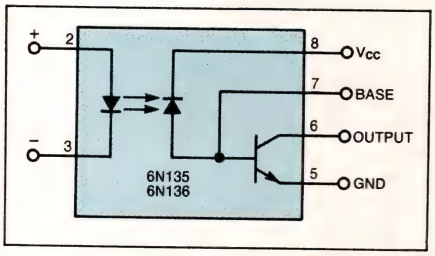
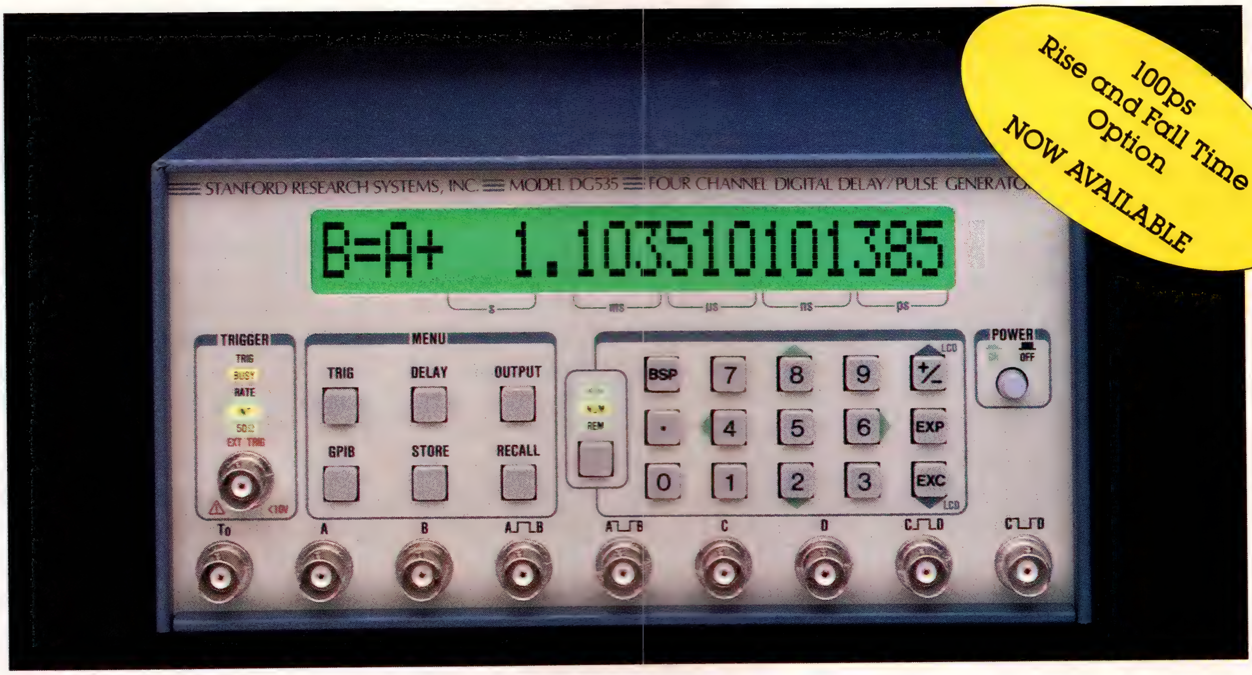


Fig 6—The 6N135 and 6N136 optocouplers are JEDEC registerd and UL approved. *The 6N135 is useful for TTL/CMOS and TTL/LSTTL applications; the 6N136, for TTL applications. The separate biasing pin for the photodiode reduces the transistor's collector-base capacitance, which speeds operation by a factor of 20 to 100 compared with conventional phototransistors. Both types are available from a number of suppliers, including Texas Instruments, General Electric, General Instrument, and Hewlett Packard.*

New Precision Pulse Generator



Four Channels, 5 ps Resolution, and GPIB Interface...Price: $2995

TIMING IS EVERYTHING

Your critical timing problems are over. No more worries about drift, jitter, or control. The DG535 Precision Pulse Generator has four delay channels (two pulse outputs), each with a 1000 second range and 5 ps resolution. The four independent delays specify two variable-width pulse outputs. With only 50 ps jitter and accuracy down to 1 ppm (option 03), the instrument can handle the most demanding applications. The internal trigger may be programmed from 0.001 Hz to 1.000 MHz, or operated in single-shot or burst modes. Output levels are continuously adjustable or may be set to TTL, NIM, or ECL levels. High impedance or 50 Ohm loads can be driven with a slew rate of 1 V/ns. Optional rear panel outputs generate pulses to 35 volts.

EASY TO USE

The delay and output levels for each channel may be entered numerically or modified by cursor keys on the backlit LCD display. Delays may be linked together so that as one moves, the other follows. Up to nine instrument settings may be stored in nonvolatile RAM for later recall, and, of course, all of the instrument's functions may be controlled via the GPIB interface.

A GENERATION AHEAD

The DG535's precision, accuracy, range, and versatility make it the solution to all your timing needs, at a price that will meet your budget. Call us today for more information.

FEATURES AND PERFORMANCE

- **Four Delay Outputs**
- **Two Variable-Width Outputs**
- **Times from 0 to 1000 sec.**
- **5 ps Resolution**
- **50 ps rms Jitter**
- **1 ppm Accuracy (Option 03)**
- **Internal or External Timebase**
- **Internal, External, Single-Shot, or Burst Mode Triggers**
- **Frequency Synthesized Rate Generator**
- **Variable, TTL, NIM, and ECL Outputs**
- **Optional ±35 Volt Outputs**
- **GPIB Computer Interface**

FRANCE
Optilas
c.e. 1422
91019 Evry Cedex
60.77.40.63, TLX 600019

GERMANY
Spectroscopy Instruments
Carl Benz Strasse 11
D-8031 Gilching
0 8105/5011, TLX 523862

JAPAN
Tokyo Instruments
Koizumi Building
6-10-13-403 Nishikasai
Edogawa-ku, Tokyo 134
03 (686) 4711, TLX J32646

Seki and Company
1-2-6, Nihonbashi Ningyocho
Chuo-ku, Tokyo 103
03 (669) 4121, TLX J24419

UNITED KINGDOM
Lambda Photometrics
Lambda House, Batford Mill
Harpenden, Herts AL5 5BZ
05827/64334, TLX 825889

Speirs Robertson
Moliver House,
Oakley Road
Bromham, Bedford
02302/3410, TLX 825633

Stanford Research Systems

1290 D Reamwood Avenue, Sunnyvale, CA 94089, TLX 706891 SRS UD, FAX 4087449049, TEL (408) 744-9040

CIRCLE NO 163

(single channel) and CLM51-2 (dual channel) LDR optocouplers from Clairex are contemporary examples.

The CLM51-2 has a center-tapped LDR as the output detector **(Fig 7)**. You can connect the typical 2-kΩ resistor elements in series or parallel to alter the total reference resistance over a 4:1 range. By varying the LED current from 0.1 to 10 mA, you can vary the reference-resistance value over a 10:1 range. The maximum current rating of the LED is 40 mA.

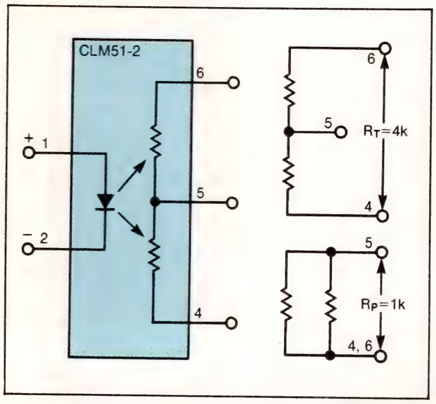


Fig 7—This optocoupler has an LDR as the detector. *You can set the reference resistance of the Clairex CLM51-2 at 1, 2, or 4 kΩ. By varying the LED current from 0.1 to 10 mA, you can vary the reference-resistance value over a 10:1 range.*

The optocoupler's frequency response, which is essentially flat from dc to 100 kHz, is more than adequate for audio applications, and its 3 dB roll-off point of 3 MHz makes it useful for higher-frequency applications. Both the single- and dual-channel versions come in 6-pin DIPs. In 100-piece quantities, the CLM-51 costs $1.74, and the CLM51-2 sells for $2.05.

EG&G Vactec also makes LDR-type optocouplers. These devices have a wide range of axial-lead types that use neon lamps, incandescent lamps, or LEDs as the light source. Available resistance values range from 100Ω to 10 kΩ.

Vactec's VTL-5 types, for example, use an LED emitter and come in plastic molded packages with either four leads (single element) or five leads (dual element). Characteristics of the VTL-5 Series, which includes seven single- and two dual-element types, are low distortion, low capacitance, and wide frequency response spanning dc to 5 MHz. In large quantities (10,000), their prices range from about $0.80 to $1.50.

Logic-oriented types of optocouplers, which make digital interfacing easier, are also available. About two years ago, General Instrument—a supplier of optoelectronic products for nearly twenty years—introduced its Optologic line of logic-to-logic couplers. These devices provide buffer and inverter interfaces for LSTTL/TTL and LSTTL/CMOS logic. The 74OL6000 Series, part of the Optologic family, includes devices with totem-pole outputs and open-collector outputs. These products have found acceptance in such applications as transmission-line receiver/driver interfaces, bus interfaces, and high-speed ac/dc voltage sensing.

General Instrument's most recent product introduction, however, is not a logic coupler. The $1.17 (5000) MCT9001 is a dual phototransistor optocoupler that features two isolated channels in a standard 8-pin DIP. The end-stackable package (two packages fit into a 16-pin DIP socket) offers a high packing density and reduced insertion costs.

The device has a CTR of 50% (min) and 600% (max) at LED currents of 5 mA. Each output transistor is rated at 50 mA (max) and has a dissipation rating of 150 mW. The MCT9001 is also fairly fast; 3 μsec turn-on and turn-off times are typical. **EDN**

For more information . . .

For more information on the optocouplers described in this article, contact the following manufacturers directly, circle the appropriate numbers on the Information Retrieval Service card, or use EDN's Express Request service.

Amperex Electronic Corp
George Washington Hwy
Smithfield, RI 02917
(401) 232-0500
Circle No 700

Clairex Electronics
560 S Third Ave
Mount Vernon, NY 10550
(914) 664-6602
Circle No 701

EG&G Vactec
10900 Page Blvd
St Louis, MO 63132
(314) 423-4900
Circle No 702

GE Solid State
Rte 202
Somerville, NJ 08876
(201) 685-6000
INQUIRE DIRECT

General Instrument
3400 Hillview Ave
Palo Alto, CA 94304
(415) 493-7055
Circle No 703

Hewlett Packard
1820 Embarcadero Rd
Palo Alto, CA 94303
Phone local office
Circle No 704

Motorola Inc
5005 E McDowell Rd
Phoenix, AZ 85008
(602) 244-3818
Circle No 705

Philips Components Div
Building BA
5600 MD Eindhoven
The Netherlands
(040) 791-111
Circle No 706

Siemens Components Inc
Optoelectronics Div
19000 Homestead Rd
Cupertino, CA 95014
(408) 257-7910
Circle No 707

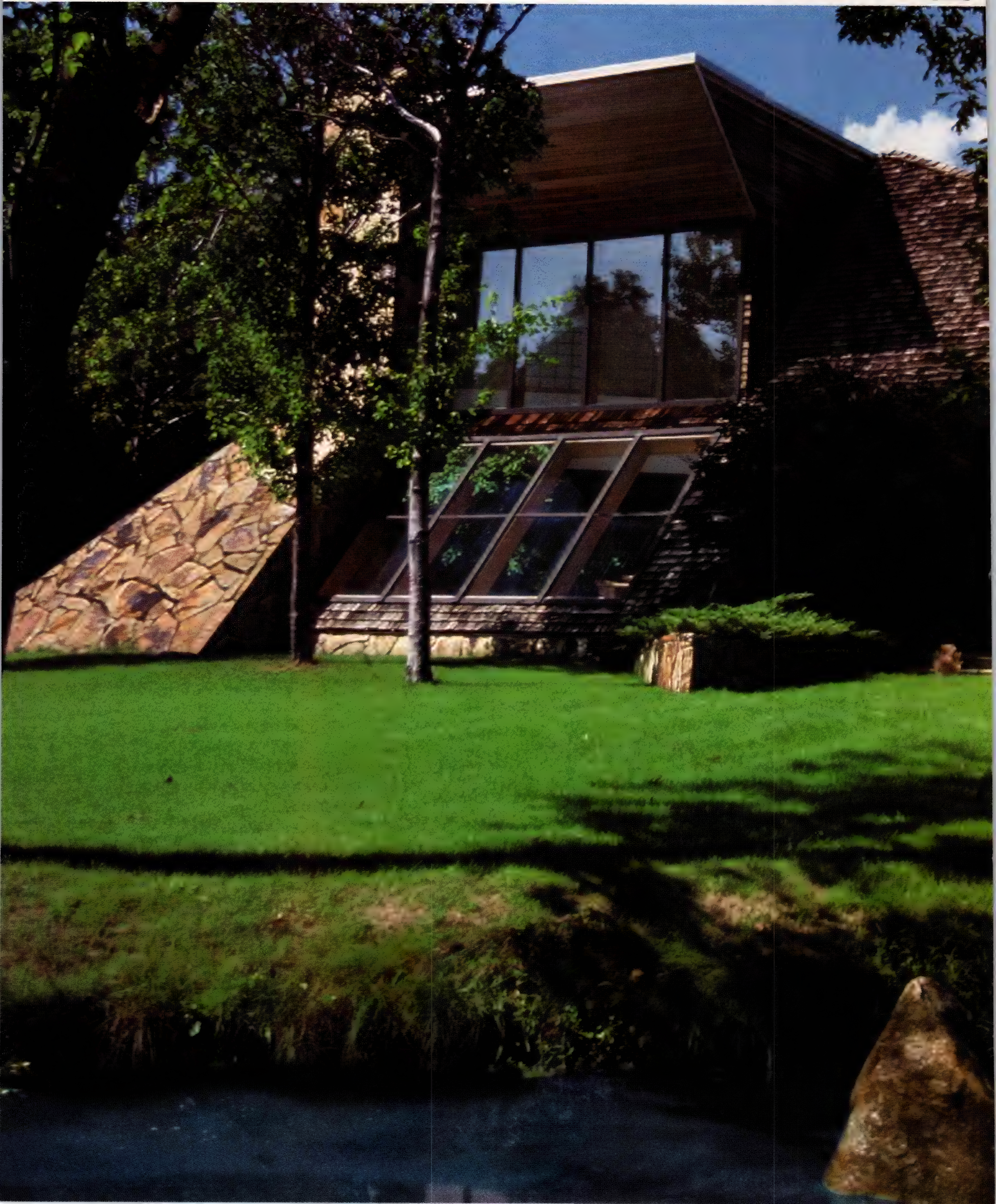
Texas Instruments Inc
Semiconductor Group (SC-801)
Box 809066
Dallas, TX 75380
(800) 232-3200
Circle No 708

Theta-J Corp
107 Audubon Rd
Wakefield, MA 01880
(617) 246-4000
Circle No 709

Article Interest Quotient
(Circle One)
High 515 Medium 516 Low 517

What do you need to build on a rough application concept?

AT&T. The comp



onents of success.

Whether you're building a visionary home—or a breakthrough product or system—getting from concept to completion demands more than bricks and mortar, or metal and silicon.

There are other components that can make a critical difference in meeting your market window on time, and on budget.

We call them the components of success—ready for immediate delivery from AT&T.

The component of commitment: here today, here tomorrow.
AT&T is in the components business to stay. We have formed a separate unit, AT&T Microelectronics, to bring our more than 100 years of electronic components experience to the marketplace. And, we have the capital, people, and technical savvy to meet our commitment to the future.

The component of innovation: AT&T Bell Labs.
Count on Bell Laboratories to help make your 'blue-sky' designs a reality. With everything from DSPs and optical data links, to custom designed products such as ASICs, multilayer boards, and power supplies. And throughout planning and manufacturing, count on AT&T to keep your product up to the minute with the latest Bell Labs advances.

The component of quality.
Through our Integrated Quality System, Bell Labs engineers work with our quality professionals to meet customer-defined criteria. At AT&T quality is our history—and our future.

The component of management involvement.
AT&T Microelectronics gives you total support, right up to its president, Bill Warwick. If our solutions aren't on the money, call him at 1 201 771-2900.

The component of quick response.
With 12 plants and an extensive network of design centers and sales offices worldwide, AT&T is ready to meet your volume demand for components. Ready with everything you need to get ideas off the ground and in the market—successfully.

To learn why AT&T is more than ever the right choice, just give us a call.

DIAL 1 800 372-2447

AT&T Microelectronics Major Product Lines:
- ASICs
- Digital Signal Processors
- Communication ICs
- 32-bit Microprocessors and Peripherals
- Solid State Relays
- Multilayer Circuit Boards
- HICs
- Optical Data Links
- Fiber Optic Components
- Power Products
- Transformers and Inductors
- Wound Film Capacitors

© 1987 AT&T

AT&T
The right choice.

CIRCLE NO 162

A REAL BRAIN FREEZER.

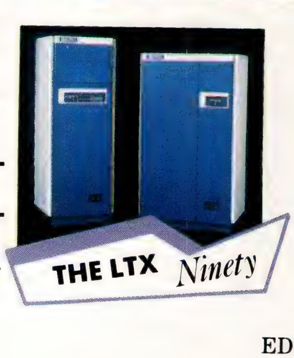
Solving complex test problems is always the name of the game at LTX.

The solution to the semiconductor industry's need for an even faster linear tester is Hi.T: combining the world's highest throughput in programming and production.

The solution to the digital market's need for a high-speed, highly accurate VLSI tester is LTX's Trillium.

And, as the industry moves into more complex mixed-signal devices, we answer with LTX Ninety: an even more sophisticated version of the LTX77—the industry standard.

The LTX Ninety offers the best price performance for



Q: Land your plane in an open area, then find a route to the stranded explorers. You may move only to a sheet on the same level or one level lower than the one you are on.
Note: Each ice sheet is either one, two, or three levels above the water. Due to perspective, some sheets that appear to touch are actually on different levels.

GAMES MAGAZINE Copyright © 1987.

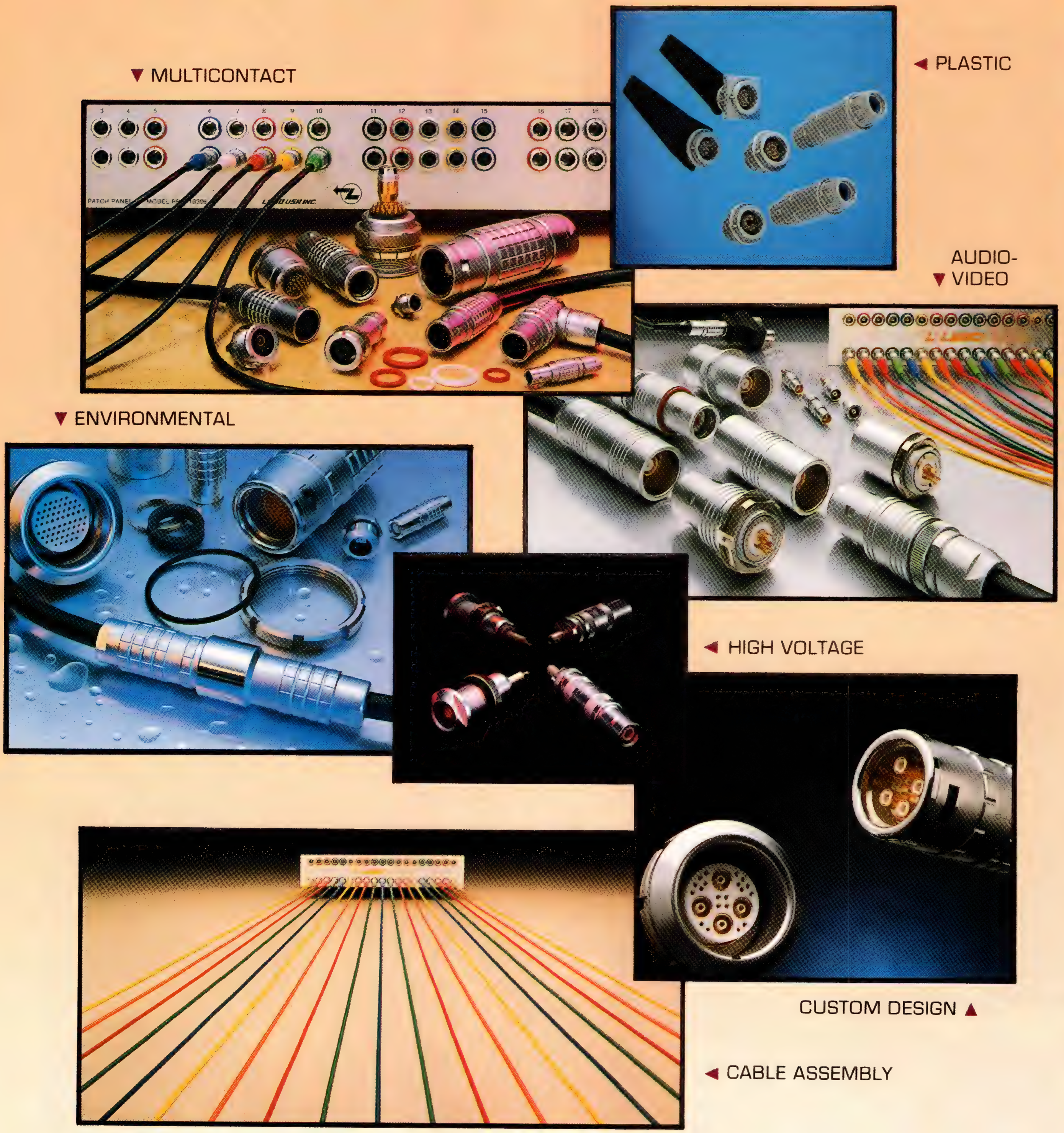
single-insertion testing of today's sophisticated mixed-signal devices. Like every LTX system, the Ninety is ultra fast, accurate and efficient—from program preparation to final test. With its expanded memory and powerful DSP (digital signal processing) software, long complex test programs become routine. And, the list of add-ons goes on and on.

The LTX Ninety. One more powerful reason why we'll continue to be the world's leading supplier of linear and mixed-signal test equipment. If you're facing a stubborn test challenge, chances are we have the solution. And, if you're also stumped by the test above, call your nearest LTX sales office for the answer to that problem, too.

LTX
TEST YOUR LIMITS.

CIRCLE NO 161

Quality is seen in every detail.



Does Your Equipment Have LEMO Connectors?

MULTICONTACT ● MIXED ● COAX ● TRIAX ● HIGH VOLTAGE
THERMOCOUPLE ● ENVIRONMENTAL ● FLUIDIC/PNEUMATIC
AUDIO VIDEO ● FIBER OPTIC ● NUCLEAR ● HERMETIC
PLASTIC ● CABLE ASSEMBLIES ● CUSTOM DESIGN

LEMO connectors feature the unique "Quick-Lok" self-latching quick connect-disconnect positive locking mechanism, gold plated contacts and rugged, space saving design.

For more information see **EEM.**

See us at Electro, Bayside Exposition Center, Booth #272

LEMO USA INC
ELECTRONIC CONNECTORS

THE QUALITY CHOICE

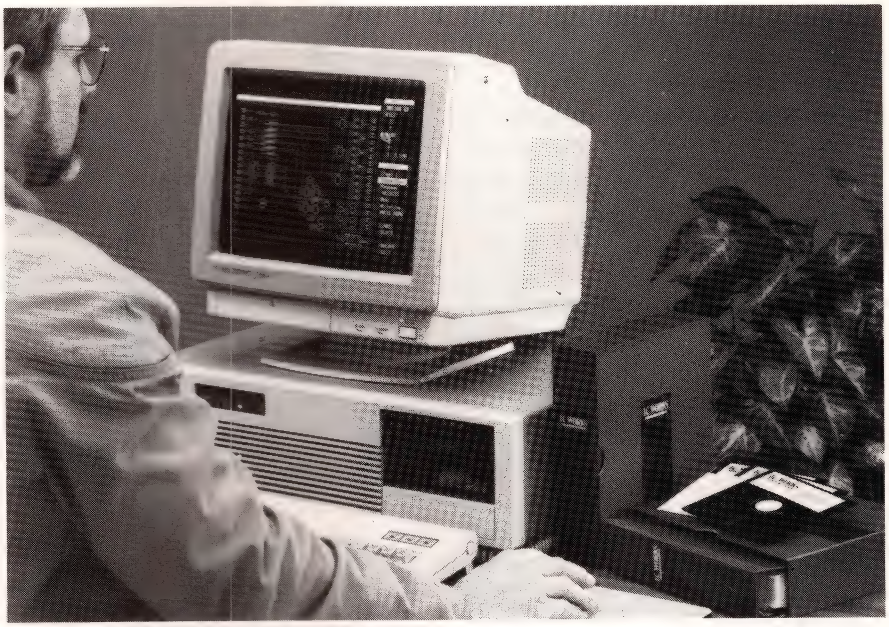
For technical data and catalog or the name of your local representative, please call or write:
LEMO USA, INC.
P.O. Box 11488, Santa Rosa, CA 95406
(707) 578-8811
telex 340-933, telefax 707/578-0869

CIRCLE NO 178

Software package relieves designer of physical details of ASIC design

You can avoid dealing with the physical design details of ASIC design if you use IC Works software to create the devices. Once you've completed the schematic capture and design verification, the computer handles the rest of the design process automatically, from cell placement through routing, clock generation, and rule checking. The complete package (including the schematic capture, cell libraries, and validation tools) sells for $10,000.

The software requires an IBM PC/AT or compatible running MS-DOS, a color monitor with an EGA card, a hard disk, and a mouse. IC Works is tailored to run on a standard computer, so it doesn't need any hardware accelerators.



When you use this automated ASIC-design package, *you don't have to deal with the physical details of the design. IC Works can generate 50 placement alternatives from 50 different initially randomized cell placements in order to provide the best solution.*

During schematic capture, you can connect as many as 14 pages of schematics in one file. You can also define macros to represent frequently used circuits, or to simplify the top-level schematic. If you don't choose to name them yourself, the computer automatically labels circuit elements and nets. Command menus or sub-menus are available on screen at all times; you can, for example, bring up a window when selecting elements for placement. Whenever you are working with a net, all nodes of the collection flash for easy identification.

The cell library for IC Works is based on a 2-μm, double-metal CMOS process and offers over 100 entries, including Boolean gates, counters, shift registers, and adders. You can add RAM, ROM, and PLA structures to your design simply by specifying their configuration and any necessary programming. You can also define custom cells by using the building blocks in the library. Thus you can make a 3-bit adder or a 5-bit counter if that is what your circuit needs. The library is not proprietary, so you can take your final design to any foundry you wish.

IC Works offers a variety of timesaving test and verification tools. While designing, you can perform logic simulation and timing verification on various parts of the design. You can then save the test vectors generated by this method for use in verifying the final design.

Initially, the automatic cell placement is randomized; then the software swaps pairs of cells until it reaches a workable routing pattern. Because the results of this technique strongly depend on the initial random placement of cells, you have the option of running an optimization routine that examines 50 different placements for the best results.

The computer can automatically place the cells and route the connections, or you can maintain complete control of the placement. In either case, the software provides complete electrical- and design-rule checking of the final layout at the transistor level.

In order to take advantage of the automatic features in IC Works, you will have to live with some restrictions. For example, you must use synchronous design techniques, because all of the storage devices in the cell library include a connection to a master clock. Some of the routines, such as the one that optimizes the device layout, take hours to run. Finally, the package handles designs limited to about 5000 gates. The company does offer a $5000 prototype fabrication service and guarantees the resulting devices will perform as simulated.

—Richard A Quinnell

IC Designs, 12020 113th Ave NE, Kirkland, WA 98034. Phone (206) 821-9202. TLX 4949856.

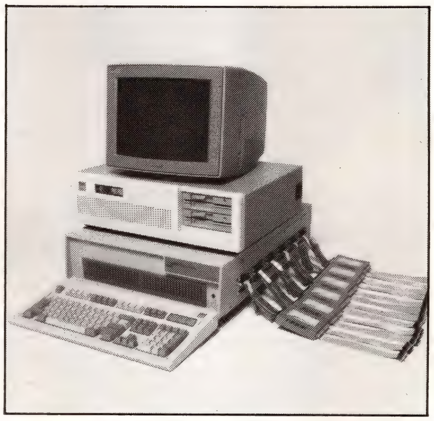
Circle No 697

Mid-range development tools streamline μprogrammable chip-based system design

By combining a comprehensive set of software tools with economical hardware—including a logic-state analyzer—the Step-50 development system improves the odds that mere mortals can develop and debug high-performance products based on microprogrammed processors. Although products using microprogrammed computing elements are faster and harder to duplicate than those based on fixed-instruction-set processors, until recently they have been quite difficult to develop because designers had to become experts in devising not only hardware but also machine-language software. Furthermore, available development systems either performed unneeded functions and cost too much, or they lacked features required to debug complex products with high confidence.

An IBM PC/AT or compatible computer hosts the Step-50. The software, based on MS/PC-DOS (version 3.x), runs under Microsoft Windows (version 2.03). An enclosure slightly larger than the PC/AT system's unit houses the hardware. It connects to the system under test via 16-channel pods; you can attach as many as ten of these pods at once. The unit's 4k-word writeable control store (WCS) supports a target-system word width of 160 bits. The 80-bit-wide, 25-MHz real-time trace memory is also 4k-words deep and is organized as a circular buffer. You can effectively increase the buffer's depth by specifying qualifications of data before storing it.

The logic-state analyzer includes clock and breakpoint controls. Using a Windows dialogue box, you can qualify trigger conditions—or data to be captured in the trace memory—with as many as five 80-bit match words and with a sequence of four independent state-machine levels. In addition, you can select sequencing from one or more of the 80-bit match words and/or from the address and data-range comparators. You control the logic-state analyzer with either the keyboard or a mouse.



***The probes used** with the mid-range Step-50 are identical to those used by the entry-level and top-of-the line members of the vendor's product line. You also use the same software with all members of the family.*

The software furnished allows you to load the WCS, edit and save its contents, compare those contents against disk files, search the WCS for data patterns, and duplicate lines or blocks of code. You can also fully define the op-code symbols and trace-display format. The system accepts bit patterns entered as binary, octal, or hexadecimal codes or as user-defined symbols. An event counter determines the number of occurrences of a selected pattern. Another software feature lets you save trace data and compare it with other traces.

The Step-50 is part of a product family that includes the Micro-Step at the low end and the Step-40 at the high end. All of the family members are PC-based. They have the same user interface and work with the same probes and compatible software. At approximately $6500 for a typical configuration, the Micro-Step is an entry-level product targeted at teaching prospective microcode developers what the process is all about. Its maximum word width is 128 bits, and it lacks a logic-state analyzer. The Step-40, which starts at about $25,000, is aimed at integration of multiple microcoded processors within systems.

The vendor believes that Step-50 is ideal for developing subsystems and systems that have a single microcoded processor. In more complex systems, where the integration of multiple processors is necessary, the Step-40 is the tool of choice.

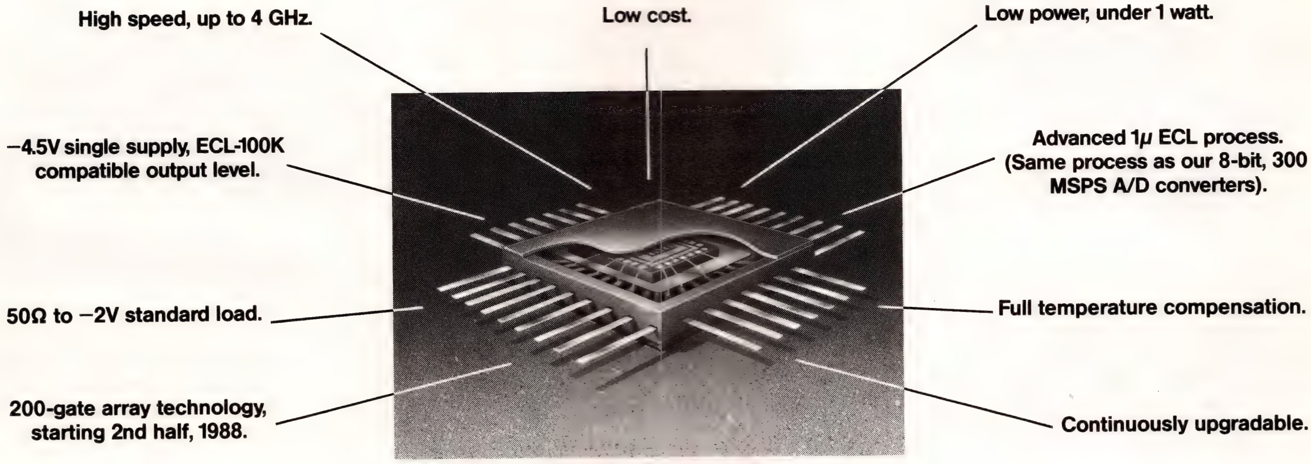
Aside from its probes, the Step-50 configuration is fixed. It costs $15,000 without probes; $16,800 with probes for 96 channels; and $18,000 when configured for the maximum of 160 channels.

—Dan Strassberg

Step Engineering, Box 3166, Sunnyvale, CA 94088. Phone (408) 733-7837. TWX 910-339-9506.

Circle No 695

SONY'S ECL LOGIC HAS THE GUTS TO CHALLENGE GaAs PERFORMANCE.


High speed, up to 4 GHz.
Low cost.
Low power, under 1 watt.
−4.5V single supply, ECL-100K compatible output level.
Advanced 1μ ECL process. (Same process as our 8-bit, 300 MSPS A/D converters).
50Ω to −2V standard load.
Full temperature compensation.
200-gate array technology, starting 2nd half, 1988.
Continuously upgradable.

When you need high-speed logic, it really pays to look into Sony's ECL logic family.

Because like GaAs technology, you'll find incredibly fast process speeds. Up to 4 GHz.

But unlike GaAs technology, you'll also find amazingly low costs and design simplicity.

Not to mention that our ECL technology, unlike most, requires very low power. Under 1 watt, in many cases.

Sony's ECL logic family is made possible by our unique 1-micron, 10-GHz, FT process. The very process that's made our high-speed, 8-bit, 300 MSPS, A/D converters so popular.

And via our 200-gate array technology, we offer a limitless range of logic functions. Many available in 24 and 32-lead flat packs. The list you see here is only partial. So if you don't see what you need, please inquire with your specific requirements.

SONY'S HIGH-SPEED ECL LOGIC FAMILY

Part Number	Function	tpd	fmax	Power	Package
CXB1100Q	Quad 3-in OR/NOR	390 ps	1.5 GHz	530 mW	24 FLAT
CXB1101Q	Quad 3-in AND/NAND	470 ps	1.5 GHz	700 mW	24 FLAT
CXB1102Q	Quad 2-in EXOR/NOR	490 ps	1.5 GHz	680 mW	24 FLAT
CXB1103Q	Quint Line Receiver	410 ps	1.5 GHz	650 mW	24 FLAT
CXB1104Q	Dual D Flip Flop	620 ps	3.2 GHz	520 mW	24 FLAT
CXB1105Q	Triple Fan-out Buffer	590 ps	1.5 GHz	720 mW	24 FLAT
CXB1106Q	4-Stage Ripple Counter		3.4 GHz	720 mW	24 FLAT
CXB1107Q	Decision Circuit		3.2 GHz	430 mW	24 FLAT
CXB1108Q	Laser Driver		2.0 GHz	740 mW	16 FLAT
CXB1109Q	Quad D-FF with Master Reset	620 ps	3.4 GHz	790 mW	24 FLAT
CXB1110Q	16 to 1 Multiplexer	610 ps	1.5 GHz	680 mW	24 FLAT
CXB1111Q	Look Ahead Carry Block	580 ps	1.5 GHz	610 mW	24 FLAT
CXB1112Q	Phase Frequency Detector	720 ps	0.8 GHz	500 mW	24 FLAT
CXB1113Q	4 to 1 Multiplexer		2.0 GHz	950 mW	24 FLAT
CXB1114Q	1 to 4 Demultiplexer		2.5 GHz	1100 mW	24 FLAT
CXB1130Q	9, 8, 4-bit Multiplexer		1.6 GHz	730 mW	32 FLAT
CXB1131Q	9, 8, 4-bit Demultiplexer		1.6 GHz	1000 mW	32 FLAT
CXB1132Q	9, 8, 4-bit Universal Shift Register		1.3 GHz	910 mW	32 FLAT
CXB1133Q	22, 15, 7-Stage Scrambler		1.6 GHz	600 mW	24 FLAT
CXB1134Q	22, 15, 7-Stage Descrambler		1.6 GHz	610 mW	24 FLAT
CXB1135Q	8-16 bit Comparator		1.3 GHz	630 mW	32 FLAT
CXB1136Q	8-bit Universal Counter		1.2 GHz	730 mW	32 FLAT
CXB1137Q	8-bit Shift Matrix	1250 ps		700 mW	24 FLAT
CXB1138Q	4-bit Arithmetic Logic Unit	1460 ps		680 mW	24 FLAT

Sony's ECL logic family is available now, backed by the quality, reliability and nationwide service you expect from any Sony product.

So get all the information on our high-speed ECL logic family today. Because when it comes to high-speed logic performance, Sony's got the guts to deliver.

Just call the Sony representative nearest you, or call (714) 229-4192. Or write Sony Corporation of America, Component Products Division, 10833 Valley View Street, Cypress, CA 90630. FAX (714) 229-4271.

SONY®

AL Huntsville (205) 533-1730
Mobile (205) 478-1036
AZ Phoenix (602) 257-9015
CA Los Angeles (714) 855-0233
San Diego (619) 729-9216
San Francisco (415) 960-3880
CO Aurora (303) 695-8903
FL (214) 234-8438
GA Norcross (404) 449-8680
IA Cedar Rapids (319) 393-2232
IL Chicago (312) 382-3001
IN Carmel (317) 844-5222
Ft. Wayne (219) 486-1912
MD Randallstown (301) 655-2265
MA Boston (617) 894-8400
MI Livonia (313) 844-5222
MN Eden Prairie (612) 944-7274
MO Bridgeton (314) 291-4230
Raytown (816) 358-8100
NJ Mt. Laurel (609) 866-1234
NM Albuquerque (505) 345-3591
NY Jamaica (718) 291-3232
Syracuse (315) 699-2671
NC Durham (919) 544-6630
Huntersville (704) 892-1366
OH Cincinnati (513) 385-1105
Cleveland (216) 261-9705
OK Tulsa (918) 744-9964
OR Tigard (503) 620-3280
PA Pittsburgh (513) 385-1105
TN Greenville (615) 639-3491
TX Austin (512) 346-9186
Houston (713) 782-4144
UT Salt Lake City (801) 264-8050
VA Sterling (703) 478-2480
WA Bellevue (206) 455-3460
Spokane (509) 924-4410
WI Waukesha (414) 542-5352

CIRCLE NO 160

NEW HIGH-PERFORMANCE, V.22 BIS MODEM CHIP SET FOR TURNKEY APPLICATIONS

SPOTLIGHT #35
IN A SERIES

SSI 73D2404
Modem Device Set

Features:
- **Three-chip, multi-mode modem device set for V.22 bis/V.22/V.21 and Bell 212A/103 applications**
- **Synchronous/asynchronous operation over dial-up or leased lines**
- **Intelligent dialing: DTMF/pulse-dialing auto-selection/full call progress detection**
- **Audible call monitor with programmable volume**
- **Voice/data switching**
- **Non-volatile dialed number storage**
- **Full loop-back modes for self-testing.**

The SSI 73D2404 V.22 bis modem device set provides designers with an easy-to-use turnkey solution for the design of conventional stand-alone 2400 BPS modem systems. The 2404's integral command interpreter minimizes design effort required, and also offers full compatibility with popular software packages used with personal computers.

The SSI 73D2404 utilizes DSP-based adaptive equalization techniques to provide error-free performance over a wide range of line conditions. In independent laboratory testing of performance, the 2404DS was proven to be superior to any other V.22 bis data pump solution currently on the market in its ability to handle line disturbances typically encountered on the public-switched telephone network.

The set is packaged in two 28-pin and one 40-pin DIP; or, for surface mount applications, one 44-pin and two 28-pin PLCC packages. Utilizing low power CMOS technology, the 2404DS draws only 600 mW from ± 5V supplies.

For more information contact: **Silicon Systems,** 14351 Myford Road, Tustin, CA 92680. Phone: **(714) 731-7110, Ext.3575.**

silicon systems
INNOVATORS IN INTEGRATION

CIRCLE NO 6

Menu-driven DMM features bar graph

The Model 560 DMM is a sophisticated DMM with an abundance of features and includes a menu-driven interface to access them all. This meter is the fifth in Simpson Electric's Professional Series of instruments—and it demonstrates an impressive and innovative change of pace. The basic unit costs $2195 and consists of a 2.5-lb Z80-based DMM that stores 2150 readings in nonvolatile, battery-backed RAM.

The 560 gives you readings with 5-digit resolution (99,999 counts); it also indicates negative polarity. Its 52-segment bar graph provides real-time voltage and autorange representations that are independent of the dB or Hz you're measuring, so you can take a reading and monitor the test point in real time simultaneously.

In addition to the standard ohms range, the meter has a high-power ohms range that is useful in testing semiconductor junctions. Other features include frequency counting, true RMS, fusing on both current inputs, diode testing, high-speed autoranging, digital filtering, a TC reference, and digital calibration. A zero function eliminates lead resistance in your readings. The unit also provides a peak-hold that is completely independent of A/D converters, so it can catch small line transients that would otherwise be lost.

The menu interface simplifies the task of selecting storage parameters for the meter's readings. Using it, you can specify the range for stored readings; you can also set the storage rate and the dB reference. A REL SET option lets you key in a reading so that subsequent input is displayed relative to that reading. The nonvolatile RAM also stores the meter's final settings so that the unit maintains the same range limits when you turn it off and on again.

Providing a menu-driven user interface, *the Model 560 digital multimeter includes a frequency counter and a dual display with bar graph.*

Two interface options are available: a Centronics-compatible parallel port or an RS-232C serial port. Each is fully isolated, has its own power supply, and costs $200. Unfortunately, there are no field upgrades, so you have to send the unit back to Simpson for an interface installation. Or you can simply order a 560 with either port already installed for $2395. If you plan to take a lot of range-limited readings, you'll want to use a printer with the meter because the 560's display doesn't provide as much information as you get on a printout.

—J D Mosley

Simpson Electric Co, 853 Dundee Ave, Elgin, IL 60120. Phone (312) 697-2260. TLX 722416.

Circle No 696

SERVING WORLD-WIDE NICHES WITH WORLD-CLASS IC PRODUCTS

What is a niche?

To many companies, a niche is a market segment targeted by the sales department. At Silicon Systems, a niche is a segment of the market in need of specialized products and services, a segment not well served by the large general-purpose companies. We target such niches at the highest level of our company—well in advance of the actual market needs. In this way, we have brought forth some of the industry's most innovative products.

The Microperipheral Niche.

While pioneering the development of single-chip read/write amplifiers for disk drives, we very early recognized the need for a family of highly integrated disk drive IC's. Today, as the leading supplier of read/write amplifiers, we also offer the industry's most complete line of integrated circuits for every other major function in disk drive electronics.

The Telecommunications Niche.

In 1979, when we were first to fully integrate a complete dual tone multiple frequency (DTMF) circuit on a chip, we also selected telecommunications as yet another important niche in need of special products and services. Today, Silicon Systems leads the industry with its highly-integrated, pin-out and register-compatible, K-Series family of modem IC's to serve operating modes world-wide.

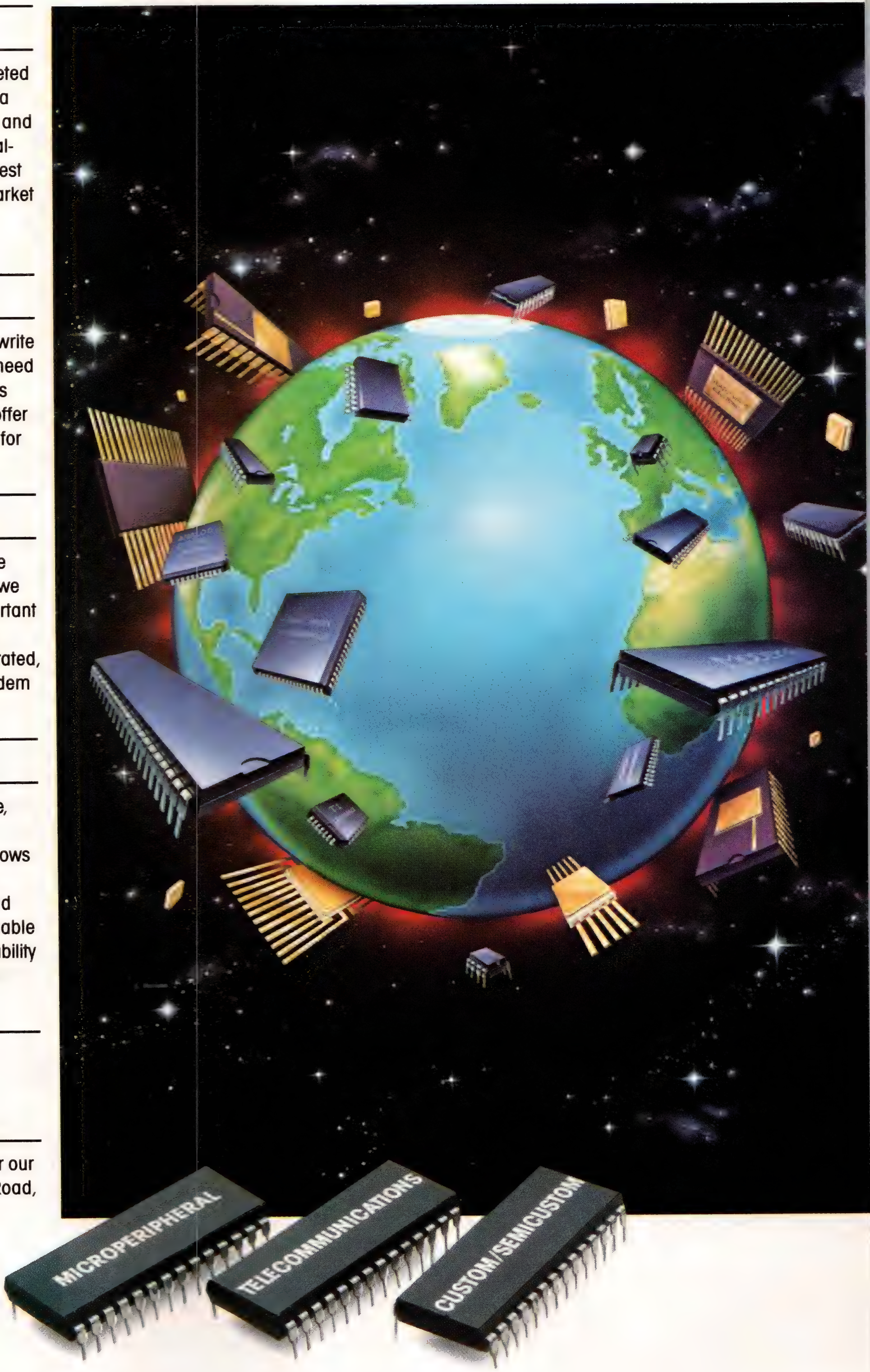
The Custom/Semicustom Niche.

And because we started life as a custom design house, superior design and engineering shall always remain paramount at Silicon Systems. It's a superiority that allows us to create and produce complex analog and digital designs on the same chip, to create special bipolar and CMOS monolithic circuits that other companies are unable to produce. It is a capability key to our success—a capability available to you for your most demanding custom and semicustom designs.

Call Now!

(714) 731-7110, Ext. 575

For more information on our company, our products or our capabilities, contact: **Silicon Systems,** 14351 Myford Road, Tustin, CA 92680.



silicon systems™
INNOVATORS IN INTEGRATION

"Where we design to your applications."

Circle 104 for Product Information

Circle 105 for Career Information

SIEMENS

Freedom of Decision – Customized

OSM-B – the microcomputer boards for Multibus® II: powerful and flexible

You use:
Multibus® II – today's most powerful and advanced, open 32-bit bus system

- High performance and 100% compatibility with other Multibus® II-boards through a hardware-integrated multiprocessor protocol and a single-chip bus interface
- Enhanced system reliability through parity protection and a synchronous bus protocol
- Reduced logistics and servicing costs through geographic addressing and integrated board tests
- Longterm savings through worldwide standardization of Multibus® II and a growing number of sources

Example:
The new CPU series OSM-Bx7 based on 80186 and 80386 processors with an onboard extension interface

The extension:
Interfacing with custom local buses
Expansion of basic board with add-on modules
Connection of SMP and AMS subsystems

The benefits:
High degree of flexibility, speedy and economic implementation of your application thanks to the constant availability of more than 150 SMP and AMS boards and RMOS 2, the realtime operating system with multiprocessor plus multitasking capability and the same software human interface from OSM-B through SMP.

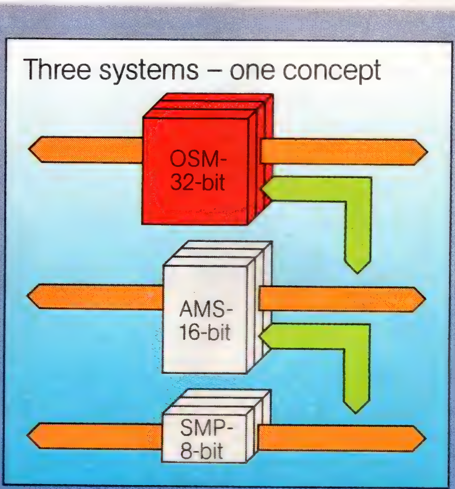
Every user can implement a customized solution to his application with OSM-B, AMS-M and SMP.

Three systems – one concept: completely compatible hardware and software building blocks from 8 to 32 bits – that gives you the fastest reaction time to changes in market demands and guarantees your competitive lead.

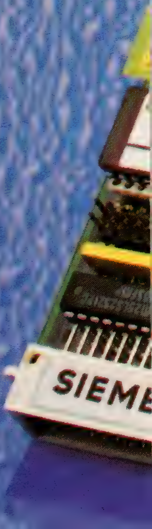
Take advantage of our experience and power of innovation to get that important step ahead.

Write Siemens AG, Infoservice 12/Z053,
Postfach 2348, D-8510 Fuerth,
quoting "OSM-B".

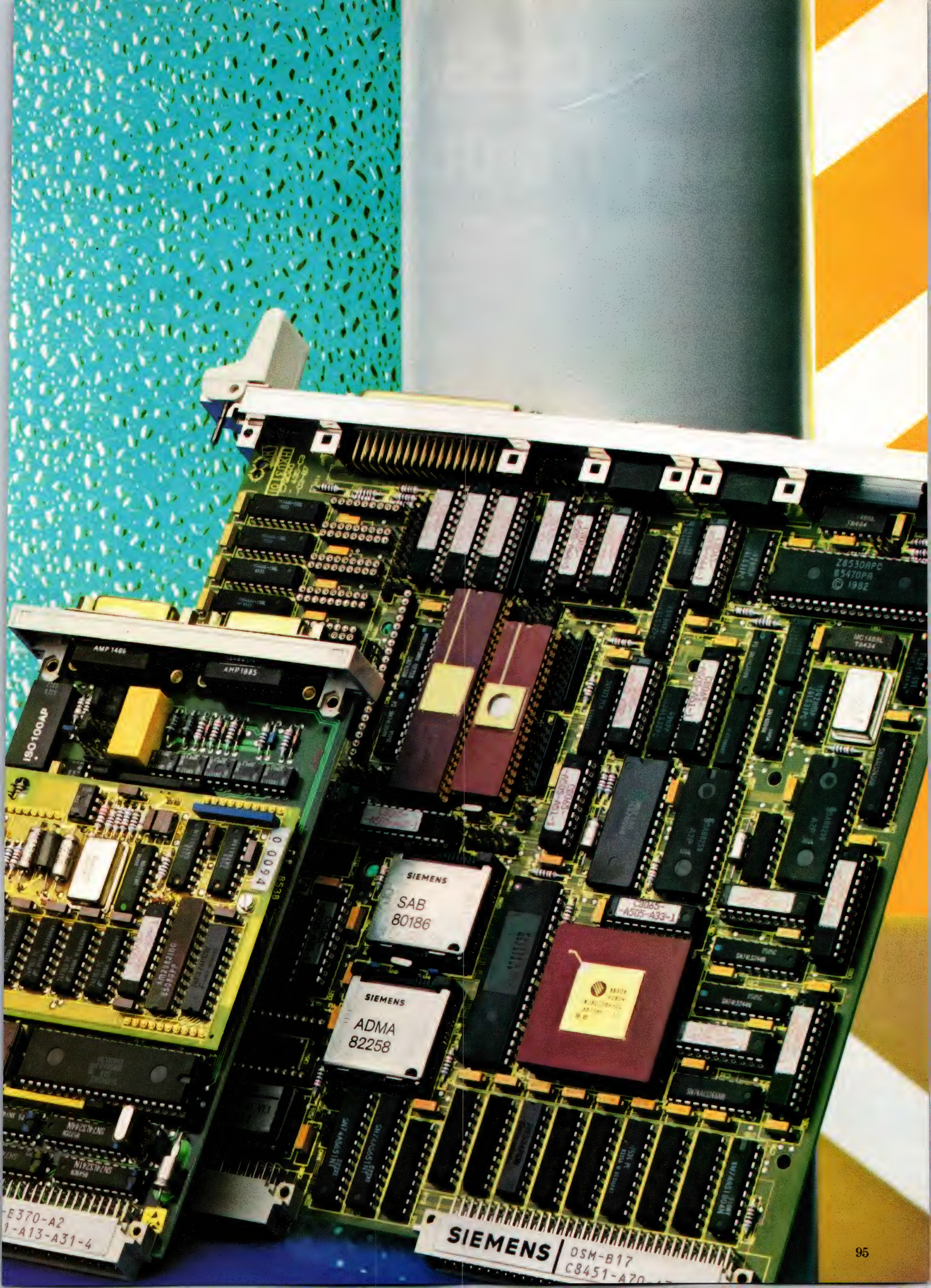
Multibus® is a registered trademark of Intel Corp.



12/Z053 e

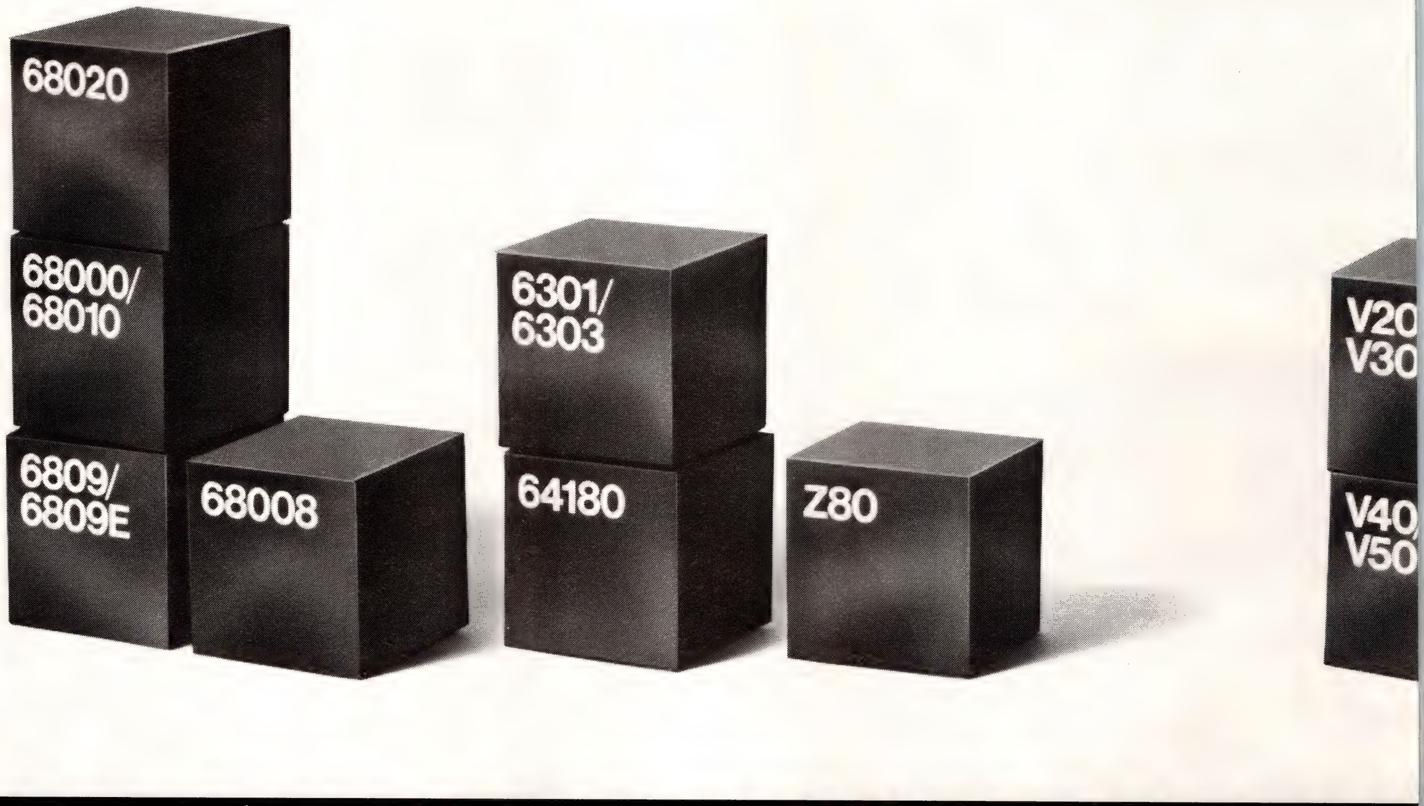


CIRCLE NO 158



SIEMENS
SAB
80186
SIEMENS
ADMA
82258
Z8530APC
© 1982
AMP 1485
AMP 1885
ISO100AP
C8085-
-A505-A33-1
0 0094
-E370-A2
-A13-A31-4
SIEMENS
DSM-B17
C8451-A70

Microprocessor Support Made Simple



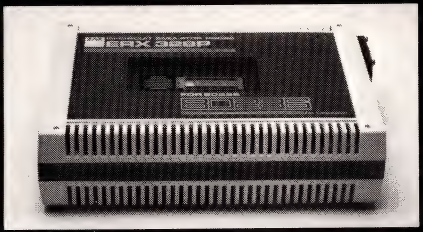
Now, ZAX simplifies microprocessor design, integration and testing with their advanced line of ERX- and ICD-series emulators. You simply tell us the processor that drives your design and we tailor a development system especially for your environment, including full software support.

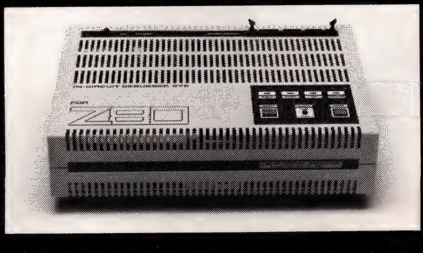
Our ERX-series emulators provide over *80 debugging commands, with 256,000 hardware breakpoints, real-time performance analysis, high-level language debug and trace analysis* of program execution while you emulate in real-time. And they interface directly to your personal computer (AT-class) to provide you with a complete host development station and emulation manager. This consolidated approach utilizes industry-standard equipment and eliminates the use of a proprietary dedicated chassis.

ZAX established the benchmark for standalone emulation tools when they introduced their versatile line of ICD-series emulators. Completely flexible, ICD-series emulators can be interfaced to *either a simple terminal or host computer* (from pc to mainframe) depending on your requirements. This makes them ideal for both *in-house development* and *on-site testing.*

ZAX

Zax Corporation





Simplify support for your microprocessor development projects with the help of ZAX! Call today to arrange a product demonstration or write for complete details about our product line. Call us TOLL FREE at 800-421-0982 (in California phone 800-233-9817) or write to ZAX CORPORATION, 2572 White Road, Irvine, CA 92714.

In Europe, call United Kingdom: 0628 476 741, West Germany: 02162-3798-0, France: (03) 956-8142, Italy: (02) 688-2141.

CIRCLE NO 157

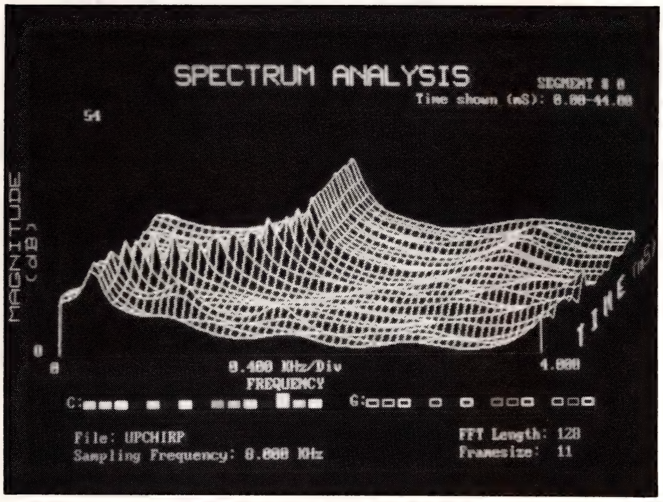
READERS' CHOICE

Of all the new products covered in EDN's **February 4, 1988,** issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, find out what makes them special: Just circle the appropriate numbers on the Information Retrieval Service card, or refer to the indicated pages in our **February 4, 1988,** issue, or use EDN's Express Request service.

MOTION CONTROLLER

The LM628 motion-control processor simplifies the control of dc and brushless dc motors by performing real-time computational tasks (pg 104).

National Semiconductor
Circle No 601



▲ DSP SOFTWARE

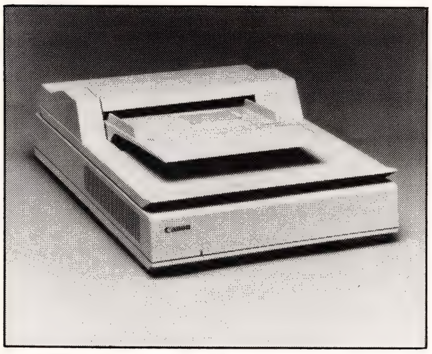
Hypersignal and Hypersignal Plus are DSP (digital signal processing) programs that run on IBM PC/XT, PC/AT, PS/2, and compatible computers (pg 240).

Hyperception
Circle No 605

▲ VISION SYSTEM

The Intellevue 386 vision computer is based on an 80386 μP with 1M bytes of zero-wait-state static RAM and an 80287 math coprocessor (pg 229).

Intelledex
Circle No 604



▲ IMAGE SCANNER

The desktop IX-12F image scanner provides 300-dot/in. image scanning for text, graphs, drawings, maps, and pictures and can enter them into a computer (pg 212).

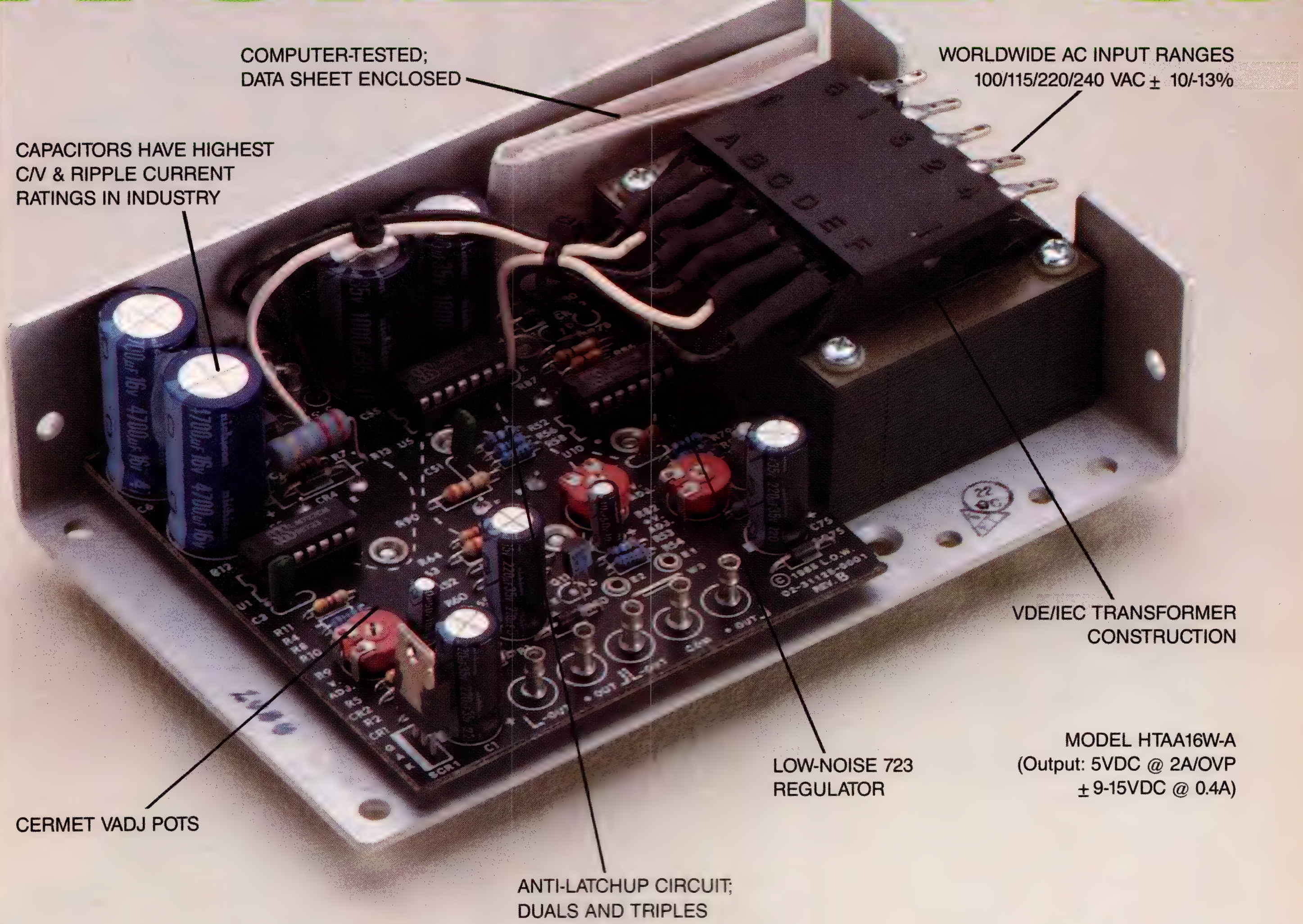
Canon USA Inc
Circle No 603

◀ CLOCK BATTERIES

The Model 843 and 844 batteries utilize a 4.5V, 1-Ahr alkaline system and replace the lithium battery that comes with all IBM PC/AT computers (pg 203).

Rayovac Corp
Circle No 602

WORLD CLASS



Condor's International linear power supplies — certified to UL544.

Condor's *International Series II* D.C. power supplies virtually eliminate primary-secondary shorting because each coil uses a separate bobbin surrounded by two layers of glass-impregnated plastic, giving complete mechanical and electrical isolation.

The best low-noise 723 regulator chips are used throughout the line, together with proven, reliable semiconductors. TO3-cased pass elements are hermetically sealed, and the latest high-density, high-ripple current rating capacitors from proven, high-quality vendors ensure long life and reliability.

International Series II features:

- 7 power levels — 3 to 150W
- 70 models (single, dual & triple output)
- OVP on all 5V outputs
- Meets EMI per FCC/VDE B (most units)
- Hermetically sealed power transistors
- MTBF 200,000 + hours per Mil Hndbk 217D
- 2-hour burn-in with cycling
- Full 3-year warranty
- 5th-generation design by Tom Ingman — most copied designer in the power supply industry

Sixty-five *International Series II* models are approved to UL478/1012; CSA C22.2 and TUV certified to VDE 0806 and IEC 435, 1 & 2. Twenty-six models are also approved to UL544. Call us today and put Condor's world-class power supplies to work for you!

Send for our free catalog!

250 power supplies!
Switchers and linears!
Open frame and enclosed!
Custom capability!

CONDOR INC.
DC POWER SUPPLIES

2311 Statham Parkway, Oxnard, CA 93030
(805) 486-4565 • TWX: 910-333-0681
FAX: (805) 487-8911
CALL TOLL-FREE: 1-800-235-5929 (outside CA)

CIRCLE NO 149

"Customers tell us… Samtec really is a different breed of cat!"

Sam Shine, Proprietor

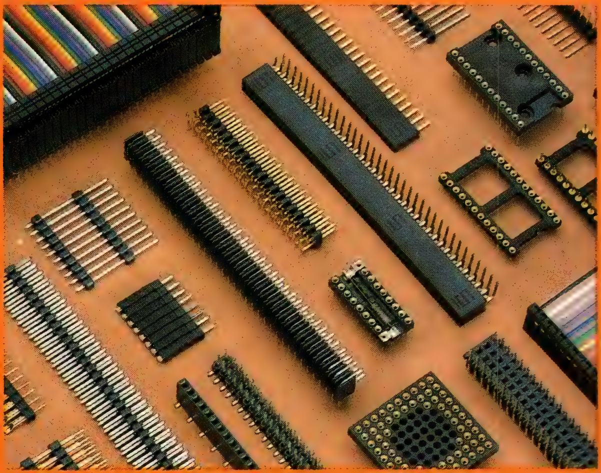
These Samtec folks make sure you get *SUDDEN SERVICE*

Samtec people believe that our customers deserve the finest products and services. Whatever you need—catalogs, samples, cross-reference guides, quotations, shipment dates—you'll get SUDDEN SERVICE that other vendors can't (or won't) match. Give us a try. You won't be disappointed.

Samtec's ***SUDDEN SERVICE*** gets the highest customer approval for product quality, on-time delivery.

Everybody claims superior products and service. We'll simply summarize and document* some of the reports we continually receive from Samtec customers who *demand* the best from their suppliers. Large companies, medium-size companies, small firms—they have all come to rely upon Samtec SUDDEN SERVICE. They have given us the highest possible quality rating for zero defect parts, on-time delivery and prompt, reliable service.

Large orders or small, they all receive the same "as promised" service that makes Samtec "a different breed of cat". Try us. You'll be pleasantly surprised.



CUSTOMER EVALUATION SCORECARD*

Customer	Product	Quality Rating for Samtec
Company "A"	Computers	100%
Company "B"	Industrial Controls	100%
Company "C"	Test Instrumentation	100%
Company "D"	Cellular Radios (Telecom)	100%
Company "E"	Medical Instrumentation	100%
Company "F"	Computers	Zero Defects
Company "G"	Telecommunications	100%
Company "H"	Industrial Motors	100%
Company "I"	Telecommunications	100%
Company "J"	Medical Instrumentation	100%
Company "K"	Heart Pacemakers	Excellent

Contact Samtec for all of your board-to-board and on-board interconnect needs. You'll find the industry's largest selection of instant break-away socket and terminal strips as well as low profile and hi-temp DIP sockets and surface mount products.

*Your Samtec salesman or distributor can show you documentation and names. They are highly respected, quality-oriented OEM's of all sizes that you'll recognize immediately.

©Samtec, Inc. 1988

EUROPEAN HEADQUARTERS: **SAMTEC, Ltd.** 35 Deerdykes View,
Westfield, Cumbernauld, Scotland G68 9HN
Phone: 02367 39292 FAX: 2367 27113 TLX: 776158

samtec **SUDDEN SERVICE**

WORLDWIDE HEADQUARTERS: **SAMTEC, Inc.** P.O. Box 1147, 810 Progress Blvd.,
New Albany, IN 47150 USA Phone: (812) 944-6733
TWX: 810-540-4095 TLX: 333-918 FAX: 812-948-5047

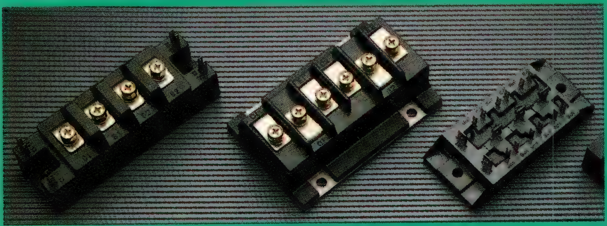
WRITE TODAY for our new 100-page full line catalog. It has been revised and enlarged to include many new products. And it contains complete specification data for fast, easy ordering. Get yours today.

CIRCLE NO 148

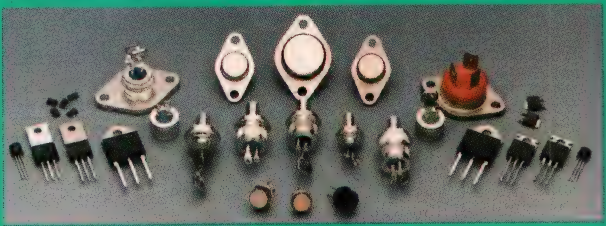
Who offers you the broadest line of power semiconductors... Darlington, FETMOD™, MOSBIP™, SCR/diode modules, rectifiers and thyristors?

Only POWEREX.

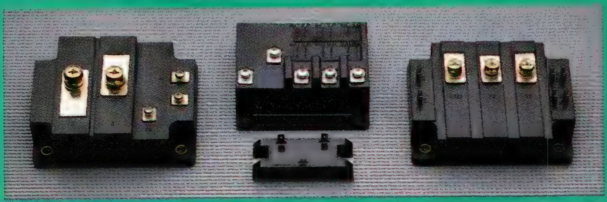
Powerex gives you what no one else does. Our one-source convenience and compatibility eliminate multi-source doubt. Our off-the-shelf availability means just-in-time delivery, instead of back-order delays or high inventory costs. We'll provide engineer-to-engineer phone conversations for an unbiased view of application needs and alternative component solutions. Best of all, POWEREX gives you leading-edge technology, rather than last-generation obsolescence. Take a look.



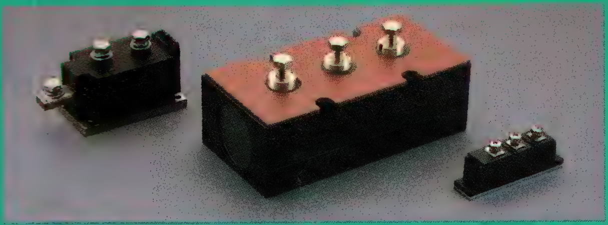
Only POWEREX offers you such a broad line of advanced power semiconductor modules, including next generation FETMOD and cascade or cascode MOSBIP, rated at 8-300 A, 50-1,000 V for applications up to 100 kHz.



Only POWEREX offers you the complete line of GE/RCA low-power triacs and SCRs as part of the broadest line of power semiconductors available.



Only POWEREX offers you more advanced Darlington modules, including Application Specific (ASM™) modules: Single device, Phase-Leg, H-Bridge, Three Phase, Chopper and Common Emitter, 5-600 A, with $V_{CEV(SUS)}$ from 200 to 1400 V.



Only POWEREX can provide a modular solution for all the key power components from logic interface devices, input rectifiers and DC regulating components to the output power stage. POWEREX now offers the world's widest array of input power stage thyristor and diode modules. Ratings of 20-800 A, with V_{DRM}/V_{RRM} from 400 to 3000 V. Circuit configurations include Single device, Phase-Leg, Three Phase Bridge and Center Tap in common cathode or common anode configuration.

Recent additions to the product line are a family of Center Tap fast recovery diodes rated at 20-100 A up to 1200 V, a new compact 150 A/1600 V Dual thyristor module, and a new 1200 V/300 A GTO thyristor module.

Only POWEREX offers you all this. For product literature, call POWEREX at 1-800-451-1415, Ext. 300. (In New York, 315-457-9334.) For application assistance, call 412-925-7272, or write POWEREX, Inc., Hillis Street, Youngwood, PA 15697.

See us at ELECTRO, Booths 2348 and 2350

POWEREX

Joint Venture Corporation of Westinghouse, GE and Mitsubishi.

CIRCLE NO 137

LEADTIME INDEX

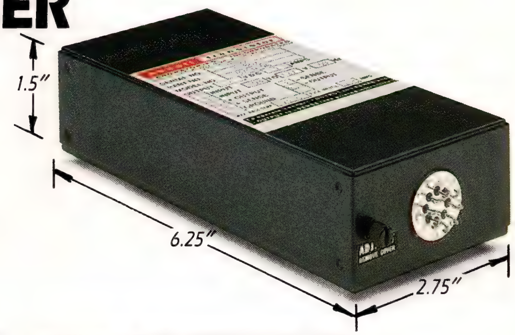
Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average (weeks)	Last month's average (weeks)
TRANSFORMERS								
Toroidal	6	23	47	18	6	0	7.2	7.3
Pot-Core	0	8	67	17	8	0	10.3	7.8
Laminate (power)	5	45	27	14	9	0	7.6	8.3
CONNECTORS								
Military panel	0	0	73	27	0	0	10.2	10.8
Flat/Cable	22	39	30	9	0	0	4.6	5.6
Multi-pin circular	9	25	25	25	8	8	8.6	9.4
PC (2-piece)	7	29	50	14	0	0	6.8	7.4
RF/Coaxial	10	50	35	5	0	0	4.6	5.3
Socket	23	54	14	9	0	0	3.6	4.7
Terminal blocks	32	59	4	5	0	0	2.3	5.4
Edge card	24	33	38	5	0	0	4.5	5.7
D-Subminiature	20	40	35	5	0	0	4.4	5.1
Rack & panel	22	36	21	21	0	0	5.8	6.4
Power	20	27	40	13	0	0	5.8	5.5
PRINTED CIRCUIT BOARDS								
Single-sided	0	47	48	5	0	0	5.6	5.4
Double-sided	0	48	48	4	0	0	5.4	5.8
Multi-layer	0	25	63	12	0	0	7.5	7.5
Prototype	0	79	13	8	0	0	3.9	4.3
RESISTORS								
Carbon film	49	27	14	10	0	0	3.3	4.2
Carbon composition	29	38	14	19	0	0	4.9	4.0
Metal film	31	35	26	8	0	0	4.1	4.4
Metal oxide	23	38	31	8	0	0	4.5	4.6
Wirewound	10	32	32	26	0	0	7.4	8.8
Potentiometers	24	40	60	16	0	0	5.0	6.1
Networks	27	32	27	14	0	0	5.0	6.3
FUSES	38	38	19	5	0	0	3.1	4.4
SWITCHES								
Pushbutton	24	43	28	5	0	0	3.9	5.8
Rotary	21	32	37	5	5	0	5.7	6.1
Rocker	11	47	32	10	0	0	5.1	5.4
Thumbwheel	6	22	55	6	11	0	8.7	7.7
Snap action	8	38	46	8	0	0	5.7	6.5
Momentary	17	33	39	11	0	0	5.5	6.3
Dual in-line	13	50	31	6	0	0	4.4	6.6
WIRE AND CABLE								
Coaxial	27	41	27	5	0	0	3.8	4.2
Flat ribbon	35	42	19	4	0	0	3.0	5.5
Multiconductor	22	50	17	11	0	0	4.1	4.6
Hookup	56	33	7	4	0	0	1.9	3.2
Wire wrap	31	50	12	6	0	0	2.9	4.2
Power cords	35	38	23	0	4	0	3.6	5.9
POWER SUPPLIES								
Switcher	11	17	50	11	11	0	9.0	7.4
Linear	11	33	45	11	0	0	6.0	7.7
CIRCUIT BREAKERS	6	26	42	26	0	0	8.0	8.0
HEAT SINKS	25	32	43	0	0	0	4.1	5.1
RELAYS								
General purpose	24	19	38	14	5	0	7.0	6.1
PC board	19	33	26	22	0	0	6.3	7.2

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average (weeks)	Last month's average (weeks)
RELAYS								
Dry reed	27	20	27	26	0	0	6.7	8.6
Mercury	20	20	30	30	0	0	7.6	9.1
Solid state	12	35	35	18	0	0	6.4	8.9
DISCRETE SEMICONDUCTORS								
Diode	37	27	18	12	3	3	5.6	7.0
Zener	37	19	18	18	4	4	7.0	7.3
Thyristor	11	21	47	11	5	5	8.8	8.8
Small signal transistor	30	10	20	30	5	5	9.5	7.4
MOSFET	10	35	20	30	0	5	8.7	10.2
Power, bipolar	19	25	19	31	0	6	8.8	9.3
INTEGRATED CIRCUITS, DIGITAL								
Advanced CMOS	12	19	44	25	0	0	7.9	9.6
CMOS	19	23	27	27	4	0	8.0	7.1
TTL	39	22	17	17	5	0	5.8	6.5
LS	33	29	14	19	5	0	6.0	5.9
INTEGRATED CIRCUITS, LINEAR								
Communication/Circuit	23	15	46	16	0	0	6.5	8.7
OP amplifier	23	14	36	18	5	4	8.6	6.3
Voltage regulator	27	11	35	19	4	4	8.3	7.2
MEMORY CIRCUITS								
RAM 16k	13	20	33	27	0	7	9.5	9.7
RAM 64k	11	37	16	31	0	5	8.5	8.8
RAM 256k	0	25	38	25	6	6	11.0	10.0
RAM 1M-bit	0	17	33	33	0	17	14.4	12.5
ROM/PROM	0	17	25	50	8	0	12.4	11.0
EPROM 64k	17	28	17	33	5	0	8.5	9.5
EPROM 256k	7	20	20	53	0	0	10.5	9.3
EPROM 1M-bit	0	18	27	46	9	0	12.2	11.6
EEPROM 16k	0	22	14	64	0	0	11.8	10.6
EEPROM 64k	0	19	25	56	0	0	11.3	10.9
DISPLAYS								
Panel meters	7	21	43	29	0	0	8.5	6.7
Fluorescent	0	18	27	55	0	0	11.3	8.5
Incandescent	20	40	10	30	0	0	6.4	6.5
LED	32	20	36	12	0	0	5.2	8.1
Liquid crystal	0	12	44	44	0	0	10.8	10.5
MICROPROCESSOR ICs								
8-bit	24	18	29	29	0	0	7.3	7.6
16-bit	6	25	19	50	0	0	10.0	9.3
32-bit	0	15	15	62	8	0	13.5	7.6
FUNCTION PACKAGES								
Amplifier	20	20	30	30	0	0	7.6	6.4
Converter, analog to digital	7	29	28	36	0	0	8.6	8.6
Converter, digital to analog	0	46	27	27	0	0	7.4	9.2
LINE FILTERS	13	20	40	27	0	0	7.9	9.4
CAPACITORS								
Ceramic monolithic	17	25	46	12	0	0	6.1	5.8
Ceramic disc	30	30	22	18	0	0	5.2	5.1
Film	14	38	19	24	5	0	7.4	4.8
Aluminum electrolytic	19	23	35	23	0	0	6.9	4.8
Tantalum	24	32	32	8	4	0	5.5	6.2
INDUCTORS	5	37	42	16	0	0	6.7	9.3

Source: *Electronics Purchasing* magazine's survey of buyers

ABBOTT'S NEW M25; A HIGHER PERFORMANCE, 25-WATT SWITCHING POWER SUPPLY



Abbott's new M25 exceeds the performance of one of the best selling mil-spec power supplies; our own VN25. Our VN25 has been widely used in critical naval and airborne applications for over 10 years. Now the M25 offers higher performance in this proven design.

Higher Density. *The M25 has a 1¼ inch lower profile than our VN25 while maintaining the same footprint. This adds up to a* ***45% reduction*** *in volume.*

Better Specs. *By doubling the switching frequency, our M25 is 10% more efficient, while at the same time providing a* ***23% wider*** *operating temperature range.*

Greater Reliability. *By using innovative design techniques, the M25 achieves a* ***4-fold increase*** *in MTBF.*

EMI Compliance. *All M25 standard units meet MIL-STD-461B for emissions and susceptibility.*

The M25 is encapsulated and hermetically sealed, and meets the stringent environmental requirements of MIL-STD-810C and MIL-S-901C.

Abbott's new M25: higher performance in a proven design.

Call or send for specs and our full line catalog.

Abbott Transistor Laboratories, Inc. Power Supply Division, 2727 La Cienega Blvd., Los Angeles, CA 90034 (213) 936-8185. Eastern Office: (201) 461-4411, Southwest Office: (214) 437-0697, London Office: 0737-82-3273.

MODEL M25 SPECIFICATIONS

DIMENSIONS	**6.25″x 2.75″x 1.5″**
Input frequency	*47-440 Hz*
Input voltage	*103.5 to 126.5 V rms*
Outputs	*5, 12, 15, 24, 28 V*
Efficiency	*70% minimum*
Ripple/noise	*20 mV rms/100 mV p-p*
Line regulation	*10 mV*
Load regulation	*25 mV*
EMI	*MIL-STD-461B*
Environment	*MIL-STD-810C* *MIL-S-901C*
Input protection	*MIL-STD-1399 sec 103*
Operating temperature range	*–20°C to 71°C*
Storage temperature range	*–55°C to 85°C*
MTBF (ground benign)*	
Standard	*176,000 hours*
ER Option	*759,000 hours*
MTBF (naval sheltered)*	
Standard	*33,000 hours*
ER Option	*125,000 hours*

**MIL-STD-217D (50°C baseplate)*

See us at AIR/SPACE AMERICA '88, Booth #671

abbott

MILITARY POWER SUPPLIES

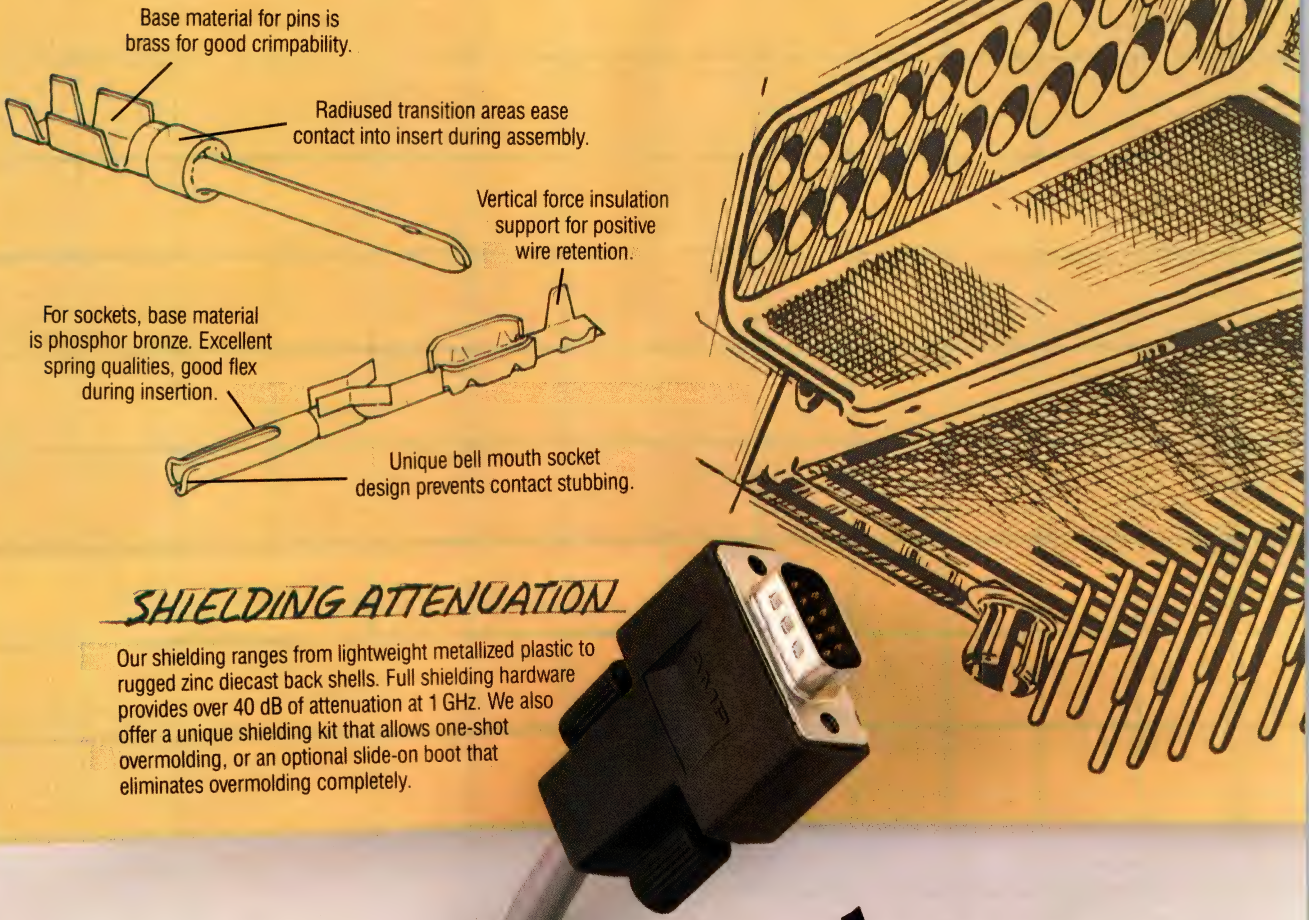
CIRCLE NO 136

PINS & SOCKETS

We electroplate. Underplating is nickel. Nickel protects the overplate from base metal corrosion. We offer gold from flash to 50 microinches. Nothing is striped or inlayed. Plating is not the place for shortcuts.

BOARDLOCKS

These boardlocks are metal for mechanical strength, and snap into place to provide positive retention without additional hardware. Plated with tin for solderability. Round for effective grounding.


Base material for pins is brass for good crimpability.
Radiused transition areas ease contact into insert during assembly.
Vertical force insulation support for positive wire retention.
For sockets, base material is phosphor bronze. Excellent spring qualities, good flex during insertion.
Unique bell mouth socket design prevents contact stubbing.
AMP

SHIELDING ATTENUATION

Our shielding ranges from lightweight metallized plastic to rugged zinc diecast back shells. Full shielding hardware provides over 40 dB of attenuation at 1 GHz. We also offer a unique shielding kit that allows one-shot overmolding, or an optional slide-on boot that eliminates overmolding completely.

Anatomy

We pay attention to details.

In materials. Contacts. Plating. Underplating. Design details that make our AMPLIMITE subminiature D connectors a quality standard.

And we pay the same attention to the details of business.

Test our reflexes.

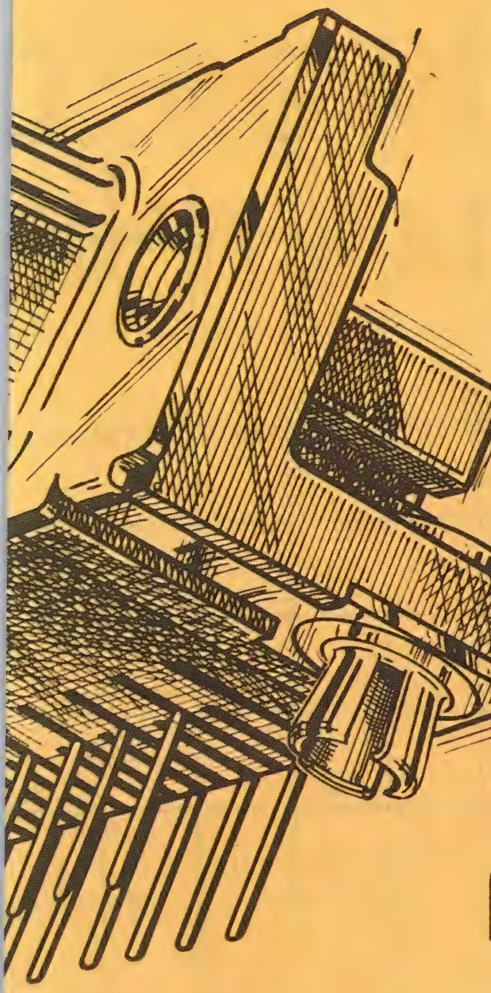
Our real job is to be the kind of company you want to do business with.

So we take availability seriously, and make AMP products available the way *you* need them. From worldwide manufacturing and stocking to our nationwide network of AMP Authorized Distributors, we offer the source that suits you.

You sometimes need parts in a rush. We've done something about that, too. We've taken our popular industry standard products—including AMPLIMITE connectors—and stocked up, nationwide.

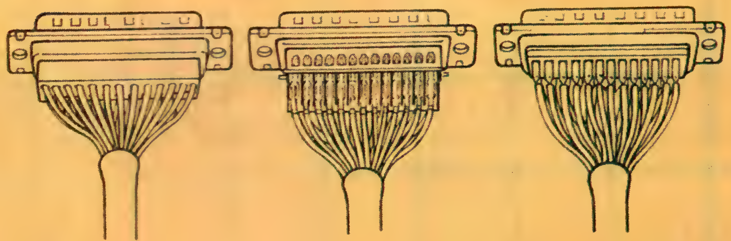
Your Immediate Shipment Catalog is ready.

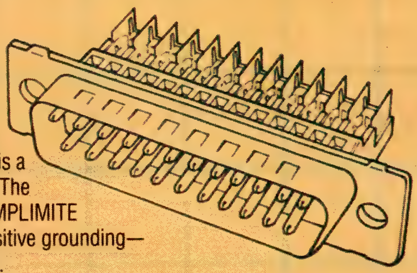
For thousands of products from switches to sockets, terminals to coax, and more, our Industry Standard Products Catalog is almost as good as a warehouse around the corner.



TERMINATION STYLES

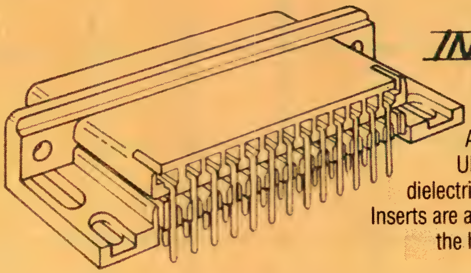
Crimp/snap-in. Insulation displacement termination. Solder cup. We engineer the wire side of an AMPLIMITE connector just as hard as we do the business end. The result is a product that works with you, and makes your work easier.





SHELLS

The grounding indent is a good index of design. The multiple indents on AMPLIMITE connectors assure positive grounding—and superior shielding.



INSERT MATERIAL

AMPLIMITE connectors are UL recognized, and use high dielectric strength insert materials. Inserts are available in 94V-0 materials, the highest flammability rating.

AMP and AMPLIMITE are trademarks of AMP Incorporated.

# of a D.

And you can get your copy just by calling our Information Center and asking for it.

One number to call.
We've consolidated our information systems into a single toll-free number, with hours to cover the business day, coast to coast.

Call us. We can supply product literature. Answer technical questions about any of our catalog products. Guide you to the closest AMP Authorized Distributor.

Any question we can't answer, any problem we can't solve on the spot, will get priority attention. It doesn't matter if your concern is a big one or a little one. Your business matters to us.

For additional technical information or the name of your local distributor, call toll-free.

We want to be your supplier.

AMP Interconnecting ideas

1·800·522·6752

CIRCLE NO 135

With our software c
the question of relia

It's just a fact of life.

Somewhere in the depths of even the simplest embedded microprocessor system design is the risk of a timing-dependent bug. Or two. And not even a million years of conventional testing can catch them all.

And that's the way it's always been.

Suppose, though, that there was a software development system that would *free you from time-dependent errors by design.*

Sound too good to be true?

It isn't. It's VRTX,® our real time software development system.

VRTX provides a comprehensive set of universal functions for handling interrupts, I/O, file management, and more. Using these functions eliminates application-killer timing errors because you don't have the chance to design them in, in the first place.

You can use VRTX as the foundation of even the most complex applications,

evelopment system, ility is a dead issue.

including those requiring multiprocessors.

And by building your application this way, you'll save time, money, and most of all, a lot of worry. Because VRTX has been proven in everything from traffic lights to underwater robots to F-14's.

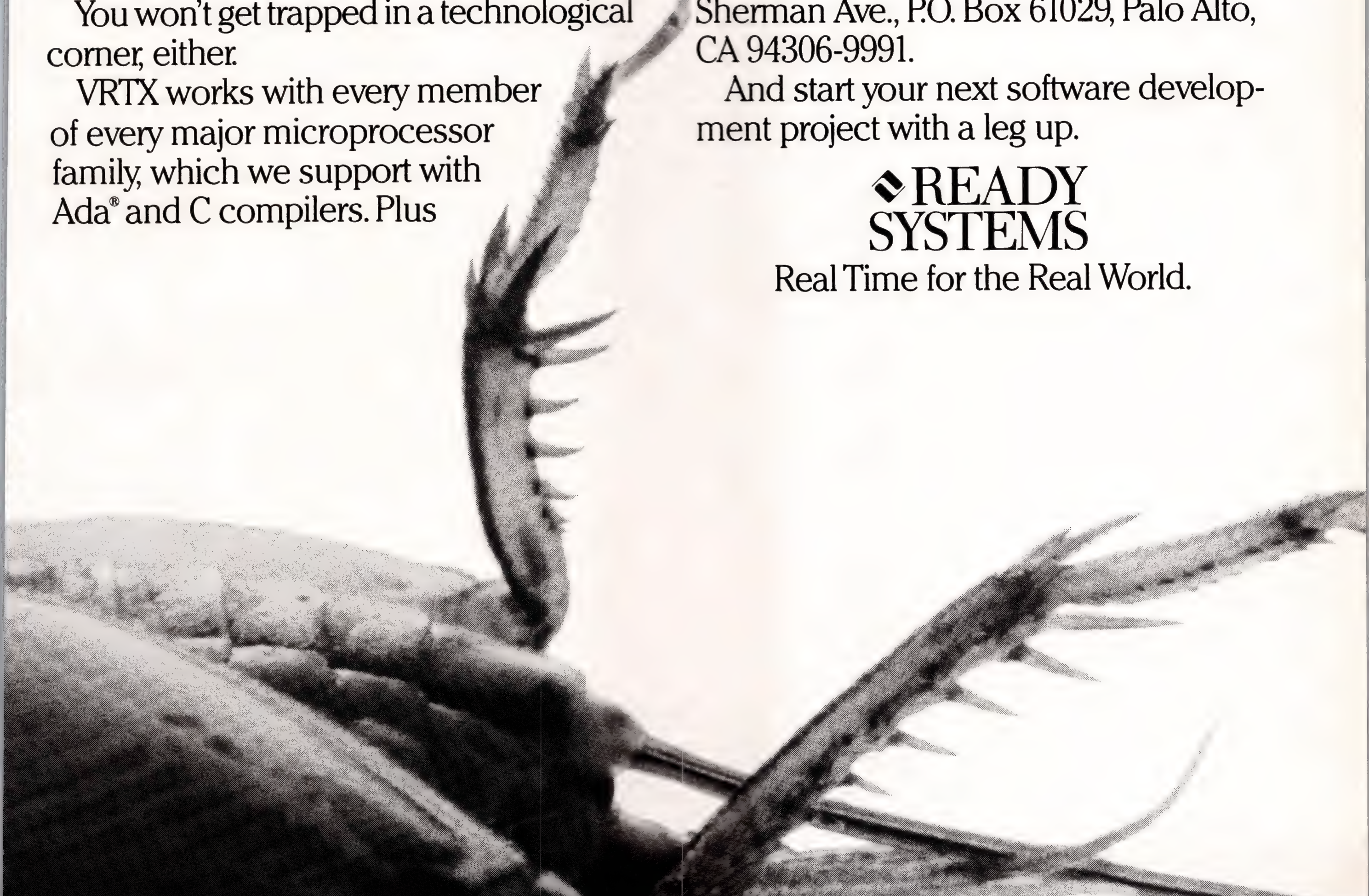
You won't get trapped in a technological corner, either.

VRTX works with every member of every major microprocessor family, which we support with Ada® and C compilers. Plus high level language libraries for other standard compilers, and a multiprocessor debugger.

So why not put out a feeler? Call us at (800) 228-1249, or (214) 661-9526 from Texas. Or write Ready Systems, 449 Sherman Ave., P.O. Box 61029, Palo Alto, CA 94306-9991.

And start your next software development project with a leg up.

READY
SYSTEMS
Real Time for the Real World.



VRTX is a registered trademark of Ready Systems. © 1987 Ready Systems Corporation.
Other brands or product names are trademarks or registered trademarks of their respective holders.

CIRCLE NO 256

Representing the life cycle of a software system as a spiral can be illuminating. Each proposed modification of the system starts a new pass through the loop comprising requirements analysis, module design, coding, and testing, and yields a result that is different (displaced) from the previous one. (Photo courtesy Index Technology)

CASE tools

More and more, CASE (computer-aided software engineering) is becoming vital to the success of large projects, and vendors are starting to make progress in filling two of the technology's most serious gaps—code generation and intertool communication.

Chris Terry, *Associate Editor*

An ideal set of CASE tools would not only help you analyze your system requirements and design the program modules to fulfill those requirements, but would also automatically generate the code, perform version-control and maintenance functions, and allow you to extract any drawing or specification or code block from the database for inclusion in the documentation. For maximum versatility, the ideal toolset would allow you to import data from or export data to other vendors' CASE tools and, by means of reverse-engineering techniques, it would help in updating existing programs and systems that weren't originally designed with CASE.

Unfortunately, the ideal CASE toolset does not yet exist. Considerable gaps in the sequence of CASE design remain, and the necessary technology, or industry-wide agreement, to fill these gaps is lacking. CASE tool vendors (of which there are currently more than 50) are well aware of these gaps, however, and are working to develop more sophisticated tools and to integrate these more closely. *(Ed Note: Because the price of a CASE toolset varies so much—from $1000 to $97,000—and because the price is so dependent on the target system and configuration you have in mind, this report does not include prices.)*

At present, the toolsets are strongest in the requirements-analysis and module-design phases—so-called front-end tools. Recently, too, reverse-engineering tools for the maintenance phase have started to become a reality. The biggest gaps still show up in the code-generation phase and in intertool-communication capabilities, but here, too, improvements are in progress.

All CASE toolsets provide a means of fully and accurately specifying *what* a software system must do: The system-requirements phase is the key to success or failure. At this stage, it's feasible and relatively inexpensive to change the design to satisfy new customer requirements, and to ensure that the logic of the design is correct and makes allowance for future changes. The ease or difficulty with which you can make such changes depends on the complexity of the project.

In a large project, it's not easy for any one designer to grasp the whole picture of what the system must do. CASE tools allow as many people as necessary to work on different parts of the design; built-in functions check the completeness and consistency of each part of the system requirements. Because CASE tools give you instant access to all sections of a design, you can look up the interfacing information that you'll need to ensure that your own section joins accurately and smoothly to the other sections.

Many of today's CASE tools offer you a choice among

At present, the toolsets are strongest in the requirements-analysis and module-design phases—so-called front-end tools.

several design methodologies for two main reasons. First, such flexibility means that you won't necessarily have to learn a new methodology to be able to use a particular tool. Second, if you're already familiar with several methodologies and their notations, you can apply the methodology that best suits your problem.

The notation and the kind of diagram available for requirements analysis vary widely according to the toolset. The most common convention is the data-flow diagram (DFD) of Yourdon and DeMarco's structured-analysis methodology, in which curved lines (representing data elements) connect circles (representing processes) and short pairs of parallel lines (representing storage areas) **(Fig 1)**. Cadre's Teamwork and Index Technology's Excelerator use this type of convention. Some tools may also use Warnier/Orr diagrams, in which each process is named at the root of a large curly brace, and where subtasks appear at the tips of the brace; they in turn are further decomposed into subtasks. Appropriately, Ken Orr & Associates' Brackets toolset uses this type. Or your tool may use Nassi-Shneiderman "structograms,"which are a form of decision table; an example is Softlab's Maestro. If your toolset is intended for database design, it is more likely that it uses Chen-Merise diagrams, which emphasize the nature and interrelationships of data structures, rather than of processes (Chen & Associates' ER-Designer utilizes these types of diagrams).

Front-end tools check internal consistency

A key feature of all system-specification CASE tools is the ability to store descriptions of data elements and processes in a database (called the data dictionary). The tools use the information in the data dictionary to crosscheck every entry, not just against the design rules of your chosen methodology, but also against your previous entries. The tools detect and report errors such as data elements that are never used, inconsistent naming of data elements, and many others.

Most tools provide many levels of detail so that you can break down a large task into a number of subtasks, and each of those, in turn, into "subsubtasks." The built-in completeness and consistency checks can help at this stage, for example, by warning you if your description of a process requires an input data element that you haven't yet defined. The decomposition of tasks is often called structured analysis (a term that Edward Yourdon and Tom DeMarco originated), and it continues until you reach a level of detail that will let you start to specify how to perform the subtasks.

When you've completed the system-requirements phase, you know what the system must do, in sufficient detail, to start identifying the program modules that will accomplish the tasks and subtasks you've specified. You're now embarking on the implementation phase—what Yourdon and DeMarco identified as structured design. Here you'll be using a different CASE tool, one that will allow you to specify not only what a program module will do, but how it will do it, its relationship to other modules, and how it will communicate with them.

The structured-design tool draws on the data dictionary that the structured-analysis tool has created, and adds new specifications to the dictionary. Here, too, built-in consistency and completeness checks prevent many of the conflicts that can arise when different programmers work on different parts of a system.

Many structured-design CASE tools, like their structured-analysis counterparts, provide a choice of methodology and allow you to apply the design methods best suited to your problem. For example, tools that implement the Boeing-Hatley extensions to DeMarco's original structured-design methodology, such as Cadre's Teamwork/RT and Index Technology's Excelerator, are particularly well-suited to the design of embedded real-time systems. The notation allows you to show the relationships between both synchronous and asynchronous events in the system.

When you've completed the implementation phase, you have a specification of each program module from which you can start coding. Some CASE tools allow the module specification in the database to contain skeleton

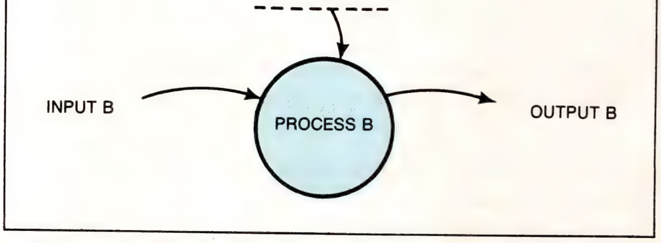


Fig 1—This simple data-flow diagram *shows the symbology of the Yourdon-DeMarco structured-analysis methodology.*

TABLE 1—REPRESENTATIVE CASE TOOLS WITH CODE GENERATORS AND REVERSE ENGINEERING

VENDOR	PRODUCT	FEATURES
ADVANCED TECHNOLOGY INTERNATIONAL	SUPERCASE	CODE FRAMES, CROSS DEVELOPMENT, REVERSE ENGINEERING
APTOOLS	APTOOLS	FULL CODE(ADA)
CADRE TECHNOLOGIES	TEAMWORK/ADA	CODE FRAMES (ADA)
COMPUTER COMMAND & CONTROL CO	MODEL	FULL CODE (ADA, C, PL/1)
HEARTLAND SYSTEMS	SOURCEVIEW	CODE FRAMES (C, COBOL, PASCAL), REVERSE ENGINEERING
ICONIX SOFTWARE ENGINEERING	POWERTOOLS	CODE FRAMES (ADA, C, FORTRAN, LISP, MODULA-2, PROLOG), REVERSE ENGINEERING
I-LOGIX	ADA PROTOTYPER	CODE FRAMES (ADA)
INTEGRATED SYSTEMS	AUTOCODE	FULL CODE (ADA, C, FORTRAN), CROSS-DEVELOPMENT
INTERACTIVE DEVELOPMENT ENVIRONMENTS	SOFTWARE THROUGH PICTURES	CODE FRAMES (ADA, C, PASCAL)
PROMOD INC	PRO/SOURCE, PROMOD/MD, RE-SOURCE	CODE FRAMES (ADA, C, PASCAL), REVERSE ENGINEERING
RATIONAL	R1000	FULL CODE (ADA) CROSS DEVELOPMENT
SCANDURA INTELLIGENT SYSTEMS	PRODOC	CODE FRAMES (ADA, C, PASCAL), REVERSE ENGINEERING
SOFTLAB	MAESTRO	CODE FRAMES (COBOL, PL/1, C)
SOFTWARE PRODUCTS & SERVICES (SPS)	EPOS	FULL CODE (ADA, C/ATLAS, FORTRAN, PASCAL, PEARL), CROSS DEVELOPMENT, REVERSE ENGINEERING
SYSCON	SKETCHER	CODE FRAMES (ADA), REVERSE ENGINEERING
TASC	ADAGRAPH	CODE FRAMES, FULL CODE (ADA), CROSS DEVELOPMENT
TELEDYNE BROWN	TAGS	FULL CODE (ADA) CROSS DEVELOPMENT

code or code fragments in the high-level language (HLL) of your choice.

It's at this point in the design sequence that you'll find one of the big gaps in CASE technology. An ideal toolset would be able to access all of the design data you've created and, from it, automatically generate a complete set of production code that would implement your design. Granted, satisfactory code generators for specialized tasks such as screen painting and report formatting have been around for several years, but designing a reliable *generalized* code generator has proven far more difficult.

Vendors are achieving some progress in this area, though, and of the more than 50 vendors of CASE tools, six now offer "full-code" generators that automatically generate 75% or more of the HLL code for implementing the program modules **(Table 1)**. Eleven other vendors offer code generators that produce either code frames or skeleton HLL code. Both of these types use the data contained in the front-end tools' central database and generate output, usually consisting of Ada, Pascal, or C statements. Code generators for Modula-2, Lisp, Prolog, PL/1, and Fortran do exist, but they are not widely available.

The full-code generators usually require that you define hardware-specific features of the target system by means of a program-definition language (PDL), and that you supply a library of previously coded low-level routines. The generators that produce code frames or skeleton code require even more manual intervention in order to ensure that new or modified hand-coded routines are reflected in the design data.

Some code generators also suffer from another problem, namely that they can't generate code for target machines with a different architecture than that of the host on which you're doing your development work. This restriction can pose a serious problem if you're cross-developing software for embedded systems. However, two vendors do offer Ada code-frame generators, and four others offer Ada full-code generators for embedded systems **(Table 1)**.

When you've completed the coding of the modules—automatically or by hand—the straightforward part of the job is over. Now the complex tasks of correlation,

> *A key feature of all system-specification CASE tools is the ability to store descriptions of data elements and processes in a database.*

testing, and configuration control begin. Most of the tools for these tasks are currently outside the realm of a CASE toolset's capabilities, but some do exist, and others are available from other vendors.

Correlation is the process of verifying that every function in the system requirements is implemented by some program module, and of identifying that module. Testing includes performance-analysis procedures to ensure that the code executes and also that every part of the code is executed at least once. CASE tools for automatic correlation and testing are rare; however, the Tektronix Tekcase toolset's Auditor tool provides a complete audit trail from system requirements to software deliverables. Also, Hewlett-Packard's HP/Teamwork toolset provides links to its AX-BA performance-analyzer tool.

Configuration control is the process of ensuring that the complete system always contains the latest version of each module. Typical tools for this are DEC's Test Management System (TMS) and Configuration Management System (CMS) and the Unix Make utility. The configuration-control process begins during the implementation phase, and continues into the maintenance phase.

Tying up the loose ends

When you've reached the maintenance phase, reverse-engineering tools can provide valuable aid in two distinct ways. First, you can use them to ensure that the final code does indeed perform all the required functions and that changes in the production code are reflected in the design database. Second, you can apply them to the source code of existing programs that require updating, maintenance, or enhancement, but were not designed with the aid of CASE tools.

For example, reverse-engineering tools, such as Re-Source in the Promod toolset and Designer in the Tekcase toolset, accept HLL source code as input,

Manufacturers of CASE tools

For more information on CASE toolsets such as the ones discussed in this article, contact the following manufacturers directly, circle the appropriate numbers on the Information Retrieval Service card, or use EDN's Express Request service.

Advanced Technology International
350 Fifth Ave
New York, NY 10118
(212) 947-4755
Circle No 650

APTools
945 Concord St
Framingham, MA 01701
(617) 875-5142
Circle No 651

Asyst Technologies
1080 Beaver Hall, Suite 1400
Montreal, Quebec, Canada H2Z 1S8
(514) 871-0108
Circle No 652

Atherton Technology
1333 Bordeaux Dr
Santa Clara, CA 94089
(408) 734-9822
Circle No 653

Cadre Technologies Inc
222 Richmond St
Providence, RI 02903
(401) 351-5950
Circle No 654

CAP Gemini Software Products
2350 Valley View Lane, Suite 420
Dallas, TX 75234
(214) 247-5454
Circle No 655

Case Technology Inc
2141 Landings Dr
Mountain View, CA 94043
(415) 962-1440
TLX 506-513
Circle No 656

Caseware Inc
1590 Corporate Dr
Costa Mesa, CA 92626
(714) 754-0308
Circle No 657

CGI Systems
1 Blue Hill Drive Plaza
Pearl River, NY 10965
(914) 735-5030
Circle No 658

Chen & Associates
4884 Constitution Ave, Suite 1-E
Baton Rouge, LA 70808
(504) 928-5765
Circle No 659

Computer Command & Control Co
2401 Walnut St, Suite 402
Philadelphia, PA 19103
(215) 854-0555
Circle No 660

Cortex Corp
138 Technology Dr
Waltham, MA 02154
(617) 894-7000
Circle No 661

Digital Equipment Corp
1 Iron Way
Marlboro, MA 01752
(617) 329-7700
Circle No 662

Disus
557 Dixon Rd, Suite 110
Rexdale, Ontario, Canada M9W 1H7
(416) 249-2246
Circle No 663

Heartland Systems
1601 Kasold Dr
Lawrence, KS 66046
(913) 749-2626
Circle No 664

Hewlett Packard
Logic Systems Div
Box 617
Colorado Springs, CO 80901
(303) 590-5889
Circle No 665

Higher Order Software Inc
Box 178
Somerville, MA 02143
(617) 628-8500
Circle No 666

Iconix Software Engineering
2800 28th St, Suite 320
Santa Monica, CA 90405
(213) 458-0092
Circle No 667

I-Logix
124 Mt Auburn St
Cambridge, MA 02138
(617) 576-5732
Circle No 668

Index Technology Corp
1 Main St
Cambridge, MA 02142
(617) 494-8200
TWX 910-380-7014
Circle No 669

Integrated Systems
2500 Mission College Blvd
Santa Clara, CA 95054
(408) 980-1500
Circle No 670

analyze it, and generate corresponding module-design and data-flow diagrams that the front-end tools can use as input. This capability allows you to utilize the full potential of CASE in a task that traditionally has been notoriously difficult and time-consuming.

All of the fundamental data necessary for proper documentation of a project is contained in the central design database originally created by the front-end tools. This data is in the form of drawings and data-element specifications, process specifications, interface specifications, and program-module specifications. The database may also contain skeleton code or substantial amounts of production code, depending on the nature of the toolset. Documentation tools can present integration problems, partly because they are, in themselves, complex systems that may be too large to be included in a CASE toolset, and partly because the best ones come from non-CASE vendors and may use an internal format incompatible with the one the CASE toolset uses.

Ways exist to overcome this incompatibility, however. One way is to arrange for the CASE tool to export text and drawings in print-image form, which the documentation tool can then treat as if it were keyboard input. Some toolsets, such as Cadre's Teamwork (which is also the basis of both the Hewlett-Packard and the Tektronix toolsets), Index Technology's Excelerator, and Teledyne Brown's Tags, now provide means by which Context's highly sophisticated documentation tool can request any data from the CASE database in print-image format. The Context tool does not directly access the design database, but can request both text and drawings in a print-image format that it can then store and incorporate into the system documentation.

The integration of different tools within a particular vendor's toolset is receiving the urgent attention of all CASE vendors except those few (Tektronix, Teledyne Brown, and SPS) that already offer toolsets that cover all phases of development from system requirements,

Interactive Development Environments
150 Fourth St, Suite 210
San Francisco, CA 94103
(415) 543-0900
Circle No 671

Ken Orr & Associates Inc
1725 Gage Blvd
Topeka, KS 66604
(913) 273-0653
Circle No 672

Knowledgeware
3340 Peachtree Rd SE, Suite 2900
Atlanta, GA 30026
(404) 231-8575
Circle No 673

Manager Software Products
131 Hartwell Ave
Lexington, MA 02173
(617) 863-5800
Circle No 674

McDonnell Douglas ISG
Dept L863, Bldg 302-1E
Box 516
St Louis, MO 63166
(800) 325-1087
Circle No 675

Nastec Corp
24681 Northwester Hwy
Southfield, MI 48075
(313) 353-3300
Circle No 676

Promod
23685 Birtcher Dr
Lake Forest, CA 92630
(714) 855-3046
Circle No 677

Rational
1501 Salado Dr
Mountain View, CA 94043
(415) 940-4700
Circle No 678

Sage Software
3200 Monroe St
Rockville, MD 20852
(301) 230-3200
Circle No 679

Scandura Intelligent Systems
1249 Greentree Lane
Narberth, PA 19072
(215) 664-1207
Circle No 680

Softlab Inc,
188 The Embarcadero
Bayside Plaza
San Francisco, CA 94105
(415) 957-9175
Circle No 681

Software Design Tools Inc
Sunset/Vine Tower, Suite 1126
6290 Sunset Blvd
Los Angeles, CA 90028
(213) 463-6102
Circle No 682

Software Products & Services Inc
14 E 38th St
New York, NY 10016
(212) 686-3790
TLX 852616
Circle No 683

Syscon
3990 Sherman St
San Diego, CA 92110
(619) 296-0085
Circle No 684

TASC
1700 N Moore St, Suite 1220
Arlington, VA 22209
(703) 558-7400
Circle No 685

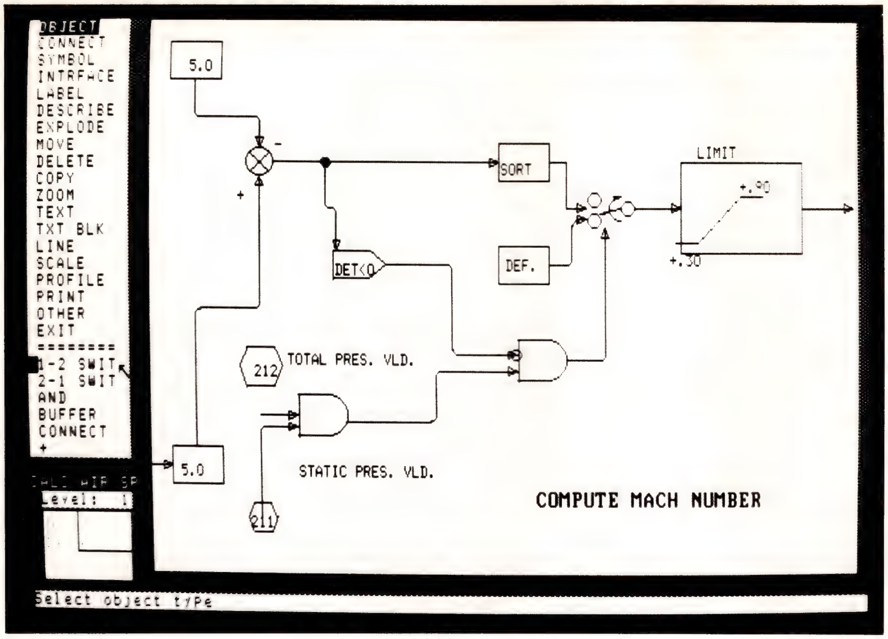
Tektronix
CASE Div
Box 4600, M/S 92-635
Beaverton, OR 97076
(503) 629-1573
Circle No 686

Teledyne Brown Engineering
300 Sparkman Dr
Cummings Research Park
Huntsville, AL 35807
(205) 532-1482
Circle No 687

Visible Systems Corp
49 Lexington St
Newton, MA 02165
(617) 969-4405
Circle No 688

Visual Software Inc
3945 Freedom Circle, Suite 540
Santa Clara, CA 95054
(408) 988-7575
Circle No 689

Yourdon Software Engineering
1501 Broadway
New York, NY 10036
(212) 391-2828
Circle No 690



CASE toolsets such as the Excelerator *from Index Technology are well-suited to embedded, real-time system design. The toolset's notation enables the portrayal of synchronous vs asynchronous events.*

through coding, to maintenance. The vendors' goal is to approach, as closely as possible, the ideal of a complete toolset whose components all generate and modify a single database throughout the life cycle of the software system. The continual use of a shared design database eliminates the synchronization problems that can arise when different team members each have a separate copy of the database.

Large projects may use a mixture of tools

Within any given toolset, integration problems arise mainly because some of the individual tools that ought to be part of a complete toolset do not exist in a form that is compatible with the other tools. Again, code generators serve as a good example of this problem. The code generator in the Maestro toolset from Softlab, for instance, requires PDL input in addition to the Nassi-Shneiderman structograms. The Teledyne Brown Tags toolset also incorporates a code generator, which receives its input from a proprietary specialized Input/Output Requirements Language (IORL) and currently generates only Ada source code (though the company intends to add VHDL ((VHSC Hardware Description Language)) as an output option during 1988). Of the six vendors who offer full-code generators, only three currently offer more than one HLL as output. Of the 10 who offer code-frame generators as part of their toolsets, five offer Ada, Pascal, and C as the output languages.

All of the other CASE toolsets available require either that you code by hand from the module-design specifications, or that you use a stand-alone code generator from some other vendor (such as DEC). The majority of such stand-alone generators are intended for management-information-system applications and generate Cobol code or code frames. However, Index Technology's Excelerator toolset does now generate diagrams that Pansophic Systems' Telon series of code generators can use directly.

A very large project may require that different vendors at widely separated geographic locations develop different portions of the project. It is possible (and even probable) that the different vendors may use different CASE toolsets, and that the coordinating agency uses yet another toolset. There is at present no easy way to export data from one CASE tool to another, but vendors are at work on this intertool-communication problem.

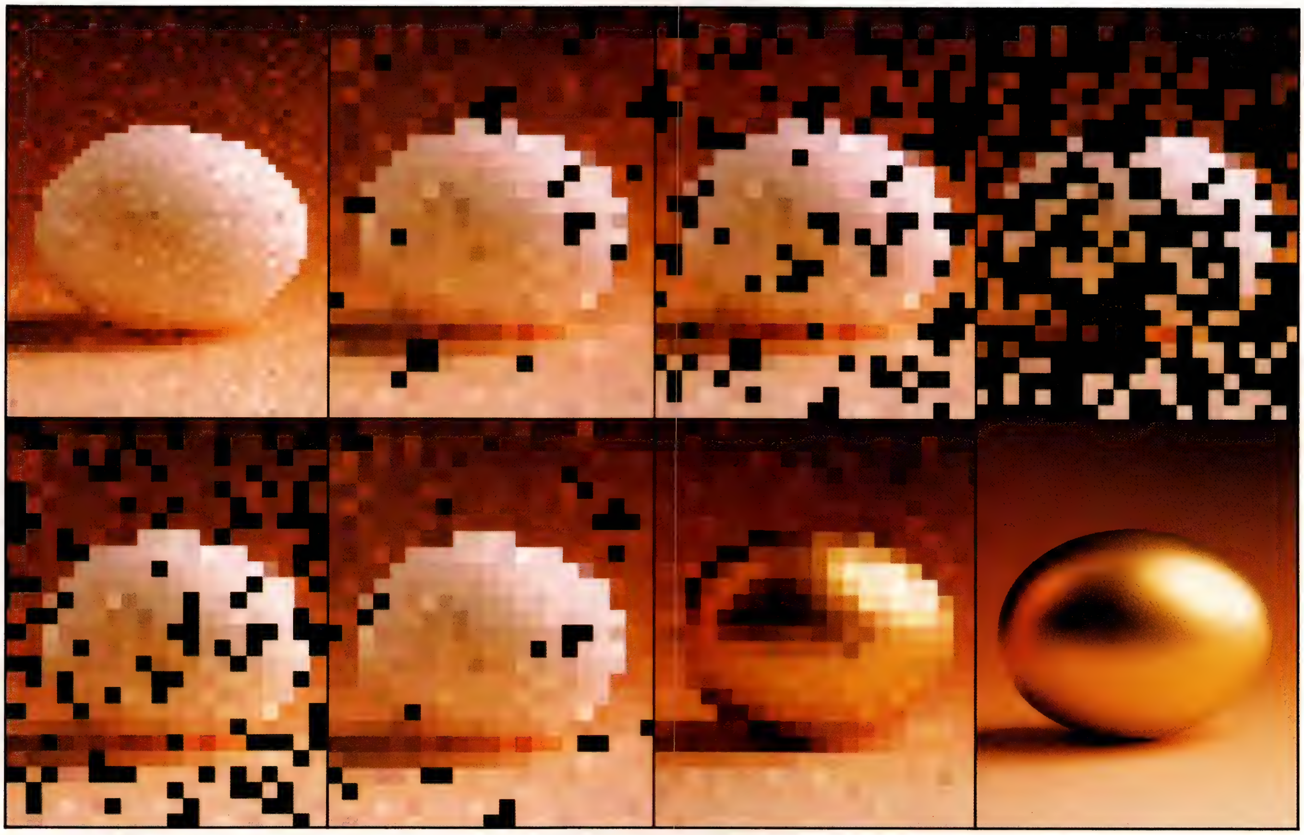
Cadre has proposed extensions to the EDIF (Electronic Data Interchange Format) that would permit the interchange of data between CASE tools from different vendors, and also between CASE and CAE tools. A committee is currently working on translating Cadre's proposals into generally acceptable form, and it's possible that the use of EDIF may prove the best means of interchanging data between incompatible CASE tools at widely separated locations. However, EDIF is not easy to use and, as yet, no wild acclamation for it has been heard.

Atherton Technology has taken a different approach to intertool communication with its 4-layered Software Backplane. This tool is designed to provide you with uniform and independent access to many different software tools, while maintaining features that are native to the hardware of the host machine.

A monitor layer, based on MIT's X-Windows, provides a common display environment that gives all CASE tools a similar look and feel. The vendor claims that this characteristic will reduce the effort needed to learn the characteristics of an entire toolset. A management-control layer provides a variety of services, including source-version control and configuration management. An object-management layer provides a repository for all project-related data and imposes a single, consistent view of the data so that a variety of incompatible tools can share the information. And finally, a portability layer contains a generalized operating system that maps Software Backplane standard serv-

TekCASE™: HOW TO BREAK A PROJECT INTO PIECES. AND PUT IT TOGETHER AGAIN.

RIGHT.



You know how to maintain control and ensure quality of a complex systems project: first you divide it into parts and work on them concurrently, then you put it back together again. You also know how seldom a project survives this kind of reassembly intact—frequently, the final result barely resembles the original intent. Tektronix, a developer of complex systems for many years, now introduces a solution to the problem. This solution is TekCASE: a complete set of software engineering tools and services to guide you through the specification, design, and documentation of even the largest and most complex systems projects. Tektronix supports the entire software development life cycle.

Finally, a flexible and extensible tool set that gives you forward *and* reverse traceability and verification. Thanks to Analyst/RT and Designer, only TekCASE provides automatic transformation from specification to design and automatic conversion from code back to design. With the addition of Auditor, providing support for software developers complying with DOD-STD 2167, only TekCASE gives you uninterrupted visibility of your project from start to finish. And TekCASE runs on any VAX® configuration.

TekCASE is more than just a software tool set—it's a strategic partnership. From project concept to code and beyond, TekCASE provides support, service, and frequent product updates. So, whether your project is in parts, back together, or somewhere in between, TekCASE is there to help you make sure the pieces fit. For more information, contact your local Tektronix representative or call 1-800-TEK-WIDE, extension 682. Tektronix, Inc., Computer-Aided Software Engineering Division, P.O. Box 14752, Portland, Oregon 97214.

Tektronix®
COMMITTED TO EXCELLENCE

™TekCASE is a trademark of Tektronix, Inc.
®VAX is a registered trademark of Digital Equipment Corp.
Copyright © 1987 by Tektronix, Inc. All rights reserved. MIA454.

CIRCLE NO 133

ices to the native functions of the host operating system.

The vendor claims that once you've ported a CASE tool to the Software Backplane, the tool will run without any change on any hardware system that is equipped with the Software Backplane. The Software Backplane is compatible with the Sun-3 family of workstations operating under Unix and with all VAX and MicroVAX systems running under VMS or MicroVMS.

The world of CASE is still developing and changing rapidly. There are already indications that in the near future some vendors will start using artificial-intelligence techniques to enhance the capabilities of their tools, especially those of code generators. For now, as you weigh the value of the various CASE tools, keep in mind certain questions: How closely is the code generator coupled to both the front-end design tools and the back-end testing and maintenance tools? How complete are the design techniques and tools? What percentage of the finished code can the generator produce? Does the generator support prototyping (that is, quick simulation of the human interface and main operations)? Does the generator support cross development?

This last question will be of particular importance to you if you are designing embedded systems, because the target machine may be very different from the host on which your CASE tools run—and some code generators generate code only for the host or a very similar machine.

Another question you may want to ask is whether the tool produces documentation that is compatible with federal or military standards. Some CASE toolsets provide documentation that fully conforms to these standards, others do not.

Happily, you can easily gain access to a wealth of information to help you in your investigation. Some sources include CASE conferences and the papers presented there; vendor-run training seminars, which help you to focus on your specific needs and on finding the tool that best suits those needs; and at least one independent monthly journal, *Case Outlook* (**Ref 1**), which is devoted to surveys of CASE technology. **EDN**

References

1. *Case Outlook*, Case Consulting Group, Portland, OR ($395/year).

2. Terry, Chris, "Customer training and reverse engineering promise to escalate the acceptance of CASE," *EDN*, March 17, 1988, pg 73.

Article Interest Quotient (Circle One)
High 470 Medium 471 Low 472

NEW! SWITCHMODE POWER SUPPLIES
FROM STOCK

- 2 to 48 VDC Outputs
- Automatic Current Sharing On All Outputs
- N+1 Capabilities

MULTIPLE OUTPUT

- 350 to 1500 Watts
- 3 to 15 Outputs

SINGLE OUTPUT

- 400 to 3000 Watts in 5″ × 8″ Standard Package
- 155,000 Hrs. Demonstrated MTBF

Hot Plug-In
FAULT TOLERANT
(N+1) POWER SYSTEMS

- Two to Six Supplies
- Expandable, 300 to 1800 Watts
- Internal Isolation Diodes (Option)

Powertec
A Bonar Power Supplies Company
20550 Nordhoff Street Chatsworth, CA 91311
(818) 882-0004 • FAX (818) 998-4225

CIRCLE NO 7

On April 5th, Intel made a major announcement about advanced 32-bit embedded control technology.

On April 12th, we'll explain it.

Intel unveiled three advanced embedded control technologies, two 32-bit embedded processors, and a radically new memory product line on April 5th.

On April 12th, seminars begin worldwide to show how to design significantly more powerful 32-bit systems that provide unparalleled price performance. The fully supported 80376 and 80960 families of embedded processors, and the breakthrough flash memory technology will be discussed in detail.

These free seminars will include lectures, comprehensive demonstrations, printed materials and a good lunch.

You're invited.

Call (800) 548-4725 for details, or to secure a spot.

And call now, as seating is limited, and we have a lot of explaining to do.

intel®

Alabama	Huntsville	4/29/88
Arizona	Tempe	4/18/88
California	Anaheim	4/22/88
	Los Angeles	4/20/88
	San Diego	4/21/88
	Santa Clara	5/4/88
	Van Nuys	4/19/88
Colorado	Denver	5/3/88
Connecticut	Stratford	4/14/88
Florida	Ft. Lauderdale	4/28/88
	Orlando	4/26/88
Georgia	Atlanta	4/25/88
Illinois	Chicago	4/12/88
Indiana	Indianapolis	5/17/88
Kansas	Kansas City	5/18/88
Maryland	Baltimore	4/26/88
Massachusetts	Boston	4/15/88
Michigan	Detroit	4/25/88
Minnesota	Minneapolis	4/14/88
Missouri	St. Louis	5/19/88
New Jersey	Kenilworth	5/13/88
New York	Binghamton	5/11/88
	Long Island	4/13/88
	Rochester	5/10/88
	Tarrytown	5/12/88
North Carolina	Charlotte	5/4/88
	Raleigh	5/3/88
Ohio	Cleveland	5/19/88
	Dayton	5/17/88
Oregon	Portland	5/6/88
Pennsylvania	Philadelphia	4/12/88
	Pittsburgh	5/18/88
Texas	Austin	4/21/88
	Dallas	4/19/88
	Fort Worth	4/18/88
	Houston	4/20/88
Virginia	Charlottesville	4/28/88
	Tysons Corner	4/27/88
Washington	Bellevue	5/5/88
Wisconsin	Milwaukee	4/13/88
Canada	Montreal	5/24/88
	Ottawa, Ontario	5/25/88
	Toronto	5/20/88
	Vancouver, BC	5/6/88

CIRCLE NO 132

MICROTEC CROSS-COMPILERS DEBUGGERS ASSEMBLERS ON MORE HOSTS FOR MORE TARGETS SO YOUR CREATION CAN LIVE FOREVER

Microtec quality and customer support have become the industry cross-development standard. What other company has the confidence to actually publish all fixes and ECOs for all products, for everyone to see? Whatever the host processor, whatever the target system, Microtec is committed to helping your software creation move from generation to generation, from technology to technology, forever. From pSOS to VRTX to MS-DOS to UNIX to VMS. From assembler to Pascal to C to Fortran. From Motorola to Intel to Hitachi to Zilog. From IBM to DEC to HP to Apollo to Sun. From crossassemblers to crosscompilers. From source debuggers running on hosts that are simulating target systems to the advanced in-circuit emulators from HP, TEK, Atron, Applied, Sophia, ZAX and Taiwan's Microtek.

There're only two phone numbers you'll ever need. Microtec's is 800-551-5554 (408-733-2919 in CA). The other is Dial-a-Prayer.

MICROTEC®
RESEARCH

3930 Freedom Circle • Santa Clara, CA 95054 • 800-551-5554 or 408-733-2919 in California

© 1987 Microtec. Microtec is a registered trademark of Microtec Research, Inc. The other companies mentioned own numerous registered trademarks. TRBA

Electro/88

For 1988, Electro's technical and tutorial program expands to 54 sessions, 35 of which focus on software. Even for those whose work doesn't involve computers, Electro offers much food for thought.

Dan Strassberg, *Associate Editor*

No beans in Boston; plenty of fish
Chinese food if that's your dish[1]

Though the estimated 45,000 EEs who descend on Boston in mid-May are certain to partake of the city's copious gustatory enticements, it's not food for the body that will attract them. Rather, it's a bountiful platter of food for thought, in the form of Electro/88—the Eastern US's largest electronics-industry show and convention. Electro alternates between Beantown and the Big Apple. This year, it's Boston's turn. Electro/88 will be served up at the World Trade Center (WTC) on Commonwealth Pier and the Bayside Exposition Center from Tuesday May 10 through Thursday May 12.

The convention's theme for 1988 is "The Technology Bridge." In a marked departure from previous Electros, the expanded, 54-session technical/tutorial program boasts 35 sessions related to software. The program emphasizes the application of software to the hardware-design process. In prior years, a computer-oriented program called Mini-Micro Northeast ran concurrently with Electro. But because computer technology is now so inextricably intertwined with every branch of electronics, Electro has subsumed Mini-Micro, which no longer exists as a distinct event.

Exhibitors include 900 companies

Most engineers who visit Electro attend not only for the professional program but also to see the wares on display and to get answers to specific technical questions from the show's exhibitors. This year, nearly 900 companies will exhibit their products in 1300 booths that will be divided approximately equally between Bayside Expo Center and the WTC. Among the exhibitors will also be some noncommercial organizations that aren't selling anything. For example, representatives of the IEEE Region I Committee on Women and Minorities and the Boston section of the Society for Women Engineers will be in Booth 2160 at the WTC to distribute information on the achievements of women and minorities in engineering.

Lester Thurow will deliver keynote address

It's an Electro custom to get up early to hear the keynote address. This year's program adheres to that tradition: The keynote breakfast will be held at 8:00 AM on Tuesday May 10 at Anthony's Pier 4 Restaurant (on

PROFESSIONAL-PROGRAM SESSIONS

WORLD TRADE CENTER

COMMERCIAL COMPLEX 1	COMMERCIAL COMPLEX 2	COMMERCIAL COMPLEX 3	TEACHERS UNION E
			TUESDAY, MAY 10
9:00 AM TO 11:30 AM **TUTORIAL 1** MARKETING, THE KEY TO PRODUCT SUCCESS	9:00 AM TO 11:30 AM **TUTORIAL 2** ELECTRICAL CAD	9:00 AM TO 11:30 AM **TUTORIAL 3** TECHNICAL DOCUMENTATION FOR ELECTRONIC PRODUCTS	9:00 AM TO 11:00 AM **SESSION 4** MODERN METEOR-BURST COMMUNICATIONS
12:30 PM TO 2:30 PM **SESSION 7** SALES AND MARKETING: CLOSING THE SOFTWARE GAP	12:30 PM TO 2:30 PM **SESSION 8** MODELING STRATEGIES FOR ASIC DESIGN	12:30 PM TO 2:30 PM **TUTORIAL 9** COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT (CALS)	12:30 PM TO 2:30 PM **SESSION 10** HIGH-TEMPERATURE SUPERCONDUCTORS
3:30 PM TO 5:30 PM **SESSION 13** EXPORTING SOFTWARE TO JAPAN—FACT OR FANTASIES	3:30 PM TO 5:30 PM **SESSION 14** DESIGN TOOLS FOR NEW PROGRAMMABLE SILICON DEVICES: DOES ONE SIZE FIT ALL?	3:30 PM TO 5:30 PM **SESSION 15** CORPORATE ELECTRONIC PUBLISHING	3:30 PM TO 5:30 PM **SESSION 16** ROBOTS IN THE REAL WORLD
			WEDNESDAY, MAY 11
9:00 AM TO 11:30 AM **TUTORIAL 19** ENGINEERING TO MEET CUSTOMER NEEDS	9:00 AM TO 11:30 AM **TUTORIAL 20** SOFTWARE DEVELOPMENT FOR REAL-TIME EMBEDDED SYSTEMS	9:00 AM TO 11:30 AM **TUTORIAL 21** DESIGN FOR TESTABILITY	9:00 AM TO 11:30 AM **TUTORIAL 22** COMPUTER INTEGRATED MANUFACTURING AND BUSINESS DECISIONS
12:30 PM TO 2:30 PM **SESSION 25** SYSTEM SOLUTIONS FOR INCREASING SALES AND MARKETING PRODUCTIVITY	12:30 PM TO 2:30 PM **SESSION 26** CASE TOOLS IMPROVE MANAGEMENT OF THE SOFTWARE CYCLE: INTRODUCTION, USAGE, HISTORIES, FUTURE TRENDS	12:30 PM TO 2:30 PM **SESSION 27** SUCCESSFUL SYSTEM-DESIGN TECHNIQUES USING ASICs	12:30 PM TO 2:30 PM **SESSION 28** CLEAN-ROOM AUTOMATION FROM CIM TO ROBOTS
3:30 PM TO 5:30 PM **SESSION 31** SOFTWARE DESIGN TECHNIQUES FOR INNOVATIVE PLD ARCHITECTURE	3:30 PM TO 5:30 PM **SESSION 32** COMPUTER-AIDED SOFTWARE ENGINEERING (CASE)	3:30 PM TO 5:30 PM **SESSION 33** CHARACTERIZATION AND TESTING OF ANALOG-TO-DIGITAL CONVERTERS FOR DIGITAL SIGNAL PROCESSING APPLICATIONS	3:30 PM TO 5:30 PM **SESSION 34** MACHINE-VISION APPLICATIONS IN ELECTRONICS MANUFACTURING
			THURSDAY, MAY 12
9:00 AM TO 11:30 AM **TUTORIAL 37** MARKETING YOUR PRODUCT, YOUR DEAL, AND YOUR COMPANY	9:00 AM TO 11:00 AM **SESSION 38** ENGINEERING EDUCATION—RESPONDING TO REAL WORLD DEMANDS	9:00 AM TO 11:00 AM **SESSION 39** STRATEGIC DEFENSE INITIATIVE: ASSESSMENT OF PROGRESS AND PROSPECTS	9:00 AM TO 11:30 AM **TUTORIAL 40** MECHANICAL CAD/CAM
12:30 PM TO 2:30 PM **SESSION 43** SIMULATION OF ANALOG AND MIXED-MODE CIRCUITS	12:30 PM TO 2:30 PM **SESSION 44** THE ROLE OF CONFIGURATION-MANAGEMENT TOOLS IN SOFTWARE DEVELOPMENT ENVIRONMENTS	12:30 PM TO 2:30 PM **SESSION 45** SOFTWARE TOOLS FOR TEST AND MEASUREMENT APPLICATION PROGRAM DEVELOPMENT	12:30 PM TO 2:30 PM **SESSION 46** HIGH-INTEGRATION SOLUTIONS FOR PERSONAL COMPUTER/PERSONAL SYSTEM DESIGN
3:30 PM TO 5:30 PM **SESSION 49** LEAP INTO THE 90s WITH AN ACCELERATED NEW-PRODUCT DEVELOPMENT CYCLE	3:30 PM TO 5:30 PM **SESSION 50** UNIQUE SOFTWARE CONSIDERATIONS FOR MICROCONTROLLERS WHEN LISTING HIGH-LEVEL LANGUAGES	3:30 PM TO 5:30 PM **SESSION 51** TEST PROGRAM GENERATION: EXTRACTING TESTER PROGRAMS FROM SIMULATION	3:30 PM TO 5:30 PM **SESSION 52** INDUSTRIAL REQUIREMENTS FOR REAL-TIME DIGITAL SIGNAL PROCESSING (DSP) APPLICATIONS

BAYSIDE EXPOSITION CENTER

TEACHERS UNION F	TEACHERS UNION G
9:00 AM TO 11:30 AM **TUTORIAL 5** IMPLEMENTING COMPUTER INTEGRATED MANUFACTURING (CIM)	9:00 AM TO 11:30 AM **TUTORIAL 6** INTRODUCTION TO GaAs DEVICES, TESTING AND EVALUATION METHODS
12:30 PM TO 2:30 PM **SESSION 11** INTRODUCING NEW PRODUCTS TO MANUFACTURING THROUGH CIM	12:30 PM TO 2:30 PM **SESSION 12** ADVENTURES IN TECHNOLOGICAL INNOVATION: HOW THE MASSACHUSETTS MIRACLE WORKS
3:30 PM TO 5:30 PM **SESSION 17** PROCESS PLANNING AND SIMULATION OF MANUFACTURING OPERATIONS	3:30 PM TO 5:30 PM **SESSION 18** DEVELOPMENT TOOLS FOR DIGITAL SIGNAL PROCESSORS (DSPs)
9:00 AM TO 11:00 AM **SESSION 23** RECENT ADVANCES IN "APPLICATION SPECIFIC" PLDs	9:00 AM TO 11:00 AM **SESSION 24** ENHANCING GLOBAL SECURITY THROUGH INFORMATION SHARING
12:30 PM TO 2:30 PM **SESSION 29** ARTIFICIAL INTELLIGENCE IN MANUFACTURING	12:30 PM TO 2:30 PM **SESSION 30** RISK ASSESSMENT AND RESPONSE
3:30 PM TO 5:30 PM **SESSION 35** PUBLISHING OPPORTUNITIES IN THE IEEE	3:30 PM TO 5:30 PM **SESSION 36** SOCIAL IMPLICATIONS OF ARTIFICIAL INTELLIGENCE
9:00 AM TO 11:00 AM **SESSION 41** COMPUTER BACKPLANE INTERFACE USING HIGH-SPEED LOW-POWER CMOS INTERFACE ICs	9:00 AM TO 11:00 AM **SESSION 42** RISC TECHNOLOGY ENTERS THE MAINSTREAM
12:30 PM TO 2:30 PM **SESSION 47** MECHANICAL CAE IMPACTS ON PRODUCT DEVELOPMENT	12:30 PM TO 2:30 PM **SESSION 48** FLOATING-POINT COPROCESSORS FOR ADVANCED PERSONAL MICROPROCESSORS
3:30 PM TO 5:30 PM **SESSION 53** SUPPORTING THE ETHICAL ENGINEER	3:30 PM TO 5:30 PM **SESSION 54** AN ARCHITECTURAL OVERVIEW OF CACHE CONTROLLERS FOR 32-BIT MICROPROCESSORS

Northern Ave near the WTC). Tickets to the breakfast cost $20; you can buy them at the door. Those who attend will be treated to a talk by internationally acclaimed economist Lester C Thurow, who is Gordon Y Billard professor of management and economics and dean of the Sloan School of Management at Massachusetts Institute of Technology (MIT). Thurow served on the Council of Economic Advisors during the administration of President Lyndon Johnson. He has written or edited 12 books, including *Poverty and Discrimination, Investment in Human Capital, The Impact of Taxes on the American Society, Generating Inequality, The Zero-Sum Society*, and *Dangerous Currents: The State of Economics*. He is also a frequent guest on television talk shows.

The 54-session professional program will start at 9:00 AM on each of the three show days. Half of the sessions will take place at the WTC's Commercial Complex; the other half will run in Teachers' Union Rooms E, F, and G at Bayside.

Technical program includes 11 tutorial sessions

Of the 54 sessions in the technical program, 11 are billed as tutorials. All the tutorials will take place from 9:00 to 11:30 AM—some at the WTC, others at Bayside. Five tutorials are scheduled for Tuesday, four for Wednesday, and two for Thursday. Because some sessions overlap, you may find it desirable to team up with a colleague, making each person responsible for attending certain sessions. For example, if you're interested in "Electrical CAD (Computer-Aided Design)" and "Implementing CIM (Computer-Integrated Manufacturing)," which will run concurrently, you can't be at both tutorials yourself.

However, in this particular instance and some others, you get a sort of second chance. If you attend the CAD tutorial on Tuesday, you can attend a tutorial on CIM and business decisions the following morning at Bayside. Readers of EDN's recent Technology Update on automatic test-pattern generation may want to make a point of obtaining further information on the subject by attending the "Design for testability" tutorial slated for Wednesday morning at the WTC.

Other tutorials of particular interest to EDN readers include Wednesday's "Software development for real-time embedded systems" and "Recent advances in application-specific PLDs," and Tuesday's "Introduction to GaAs devices: testing and evaluation methods."

Many of the sessions not billed as tutorials also cover subjects in which EDN readers have indicated great interest. One such is "Design tools for new programmable silicon devices: does one size fit all?" This session will be held on Tuesday from 3:30 to 5:30 at the WTC. Another especially significant session takes place at the same time at Bayside. It's entitled "Development tools for digital signal processors (DSPs)."

Wednesday features a cluster of sessions sure to attract many EDN readers: for example, "CASE tools improve management of the software cycle: introduction, usage, histories, future trends;" "Successful sys-

Please come to Boston (but don't bring your car)

Very few people haven't heard what a nightmare it is to drive in Boston. Though Boston drivers' reputation for daring and erratic behavior may be undeserved, even the most well-adjusted motorist is bound to be daunted by the scarcity of parking spaces and the inscrutable, albeit quaint, web of narrow one-way streets, which were literally laid out by eighteenth-century cows seeking the Common grazing ground. Furthermore, the zeal of the Boston Police Department's meter attendants is deservedly legendary, and, to top it all, despite some recent improvement, Massachusetts retains the title of car-theft capital of the world.

It's a good idea, therefore, not to drive to Boston if you can avoid it. With that caveat in mind, here's how to get to Electro/88 while preserving a least a portion of your sanity: Take Boston's MBTA or "T," which is a (pretty decent) public transportation system.

The Red Line gets you there

Both the World Trade Center (WTC), which is located at Commonwealth Pier on Northern Ave (in the South Boston section of the city) and the Bayside Exposition Center (in the Dorchester section) are within walking distance of the Red Line, one of the T's four major rapid-transit lines. The WTC is near the South Station stop; the Bayside Exposition Center is near the JFK Library/U Mass stop on the Ashmont branch of the Red Line.

If you don't feel like walking the approximately 1½ miles from South Station to the WTC, you can take the City Point (No 7) bus, which stops close to the WTC. Similarly, if you don't feel like walking to Bayside from the JFK/U Mass Red Line station, you can take the No 8 bus or a shuttle run by Brush Hill Transit Co. Be sure to have a supply of quarters handy whenever you plan to ride a T bus. The T doesn't allow its drivers to accept bills or to make change.

Shuttle links WTC and Bayside

To travel between the Bayside Exposition Center and the World Trade Center, you can take one of the shuttle buses; they'll run continuously during the hours when Electro is open and will also stop at major Boston hotels.

If, despite all warnings, you insist on driving all the way to Electro, you can pay to park in a large lot at Bayside Exposition Center or another at the WTC. There will be additional parking for show attendees (for a fee) near Anthony's Pier 4 Restaurant on Northern Ave not far from the WTC. Remember, though, that the total capacity of these lots is approximately 3900 cars, and Electro's attendance will exceed 45,000 people.

To reach the Bayside Expo Center from north of Boston, take Interstate 93 south to exit 15 and follow the signs. From the south, take I-93 north to either exit 14 or 15 and follow the signs. From the west, take the Mass Pike to its terminus at I-93, and follow I-93 south to exit 15, then follow the signs.

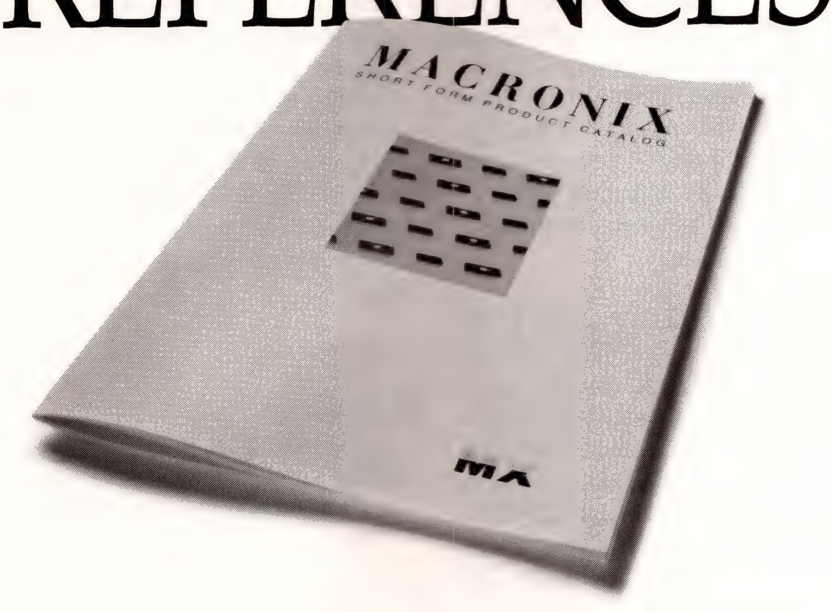
If you're driving and are unfamiliar with Boston, it's probably better to park at Bayside and take the shuttle to the WTC than to attempt to park at or near the WTC.

If you pay at the door and are not a member of the IEEE or ERA (Electronic Representatives Association), admission to Electro will cost $20 for both the exhibits and the technical sessions. Admission for members is $10. For those who preregistered by mail prior to April 21, the cost was $5.

Exhibit hours are 9:30 AM to 5:00 PM on all three days. The professional program's hours are 9:00 AM to 5:30 PM on all three days.

When using the Electro Products section of EDN to plan your visits to exhibitor booths, remember that booths 1 to 1899 are at Bayside, and 1900 and above are at the WTC.

IF YOU NEED QUICK-TURN ROM, CHECK OUR REFERENCES.



If you've been looking for a reliable, and fast, supplier of mask ROMs look into the Macronix Quick-Turn ROM Catalog. You'll find a broad selection of ROMs in densities from 16 kbits to 1 Mbit. And delivery schedules that put finished product in your hands fast.

How fast? Domestic production lets us turn the lower density ROM prototypes in two to three weeks. So you can meet the demands of your market now, rather than waiting for shortages to end, whether it's EPROMs or ROMs.

For more information, ask for your copy of the Macronix Quick-Turn ROM Catalog. You'll find it's one of your most useful reference books. Macronix Inc. 2680 N. First Street. San Jose, CA 95134. (408) 434-1133. FAX (408) 434-1136.

MACRONIX PRODUCT LIST – ROMs

Device	Size	Organization	Speed	Technology	Pins	Availability
MX2316B	16K	2K × 8	150 ns	HMOS	24	NOW
MX2332/33	32K	4K × 8	150 ns	HMOS	24	NOW
MX2364	64K	8K × 8	150 ns	HMOS	24	NOW
MX2365/66	64K	8K × 8	150 ns	HMOS	28	Q288
MX23128/29	128K	16K × 8	150 ns	HMOS	28	Q288
MX23256	256K	32K × 8	175 ns	HMOS	28	NOW
MX23512	512K	64K × 8	200 ns	HMOS	28	NOW
MX231024	1M	128K × 8	200 ns	HMOS	28	NOW
MX23C1024	1M	128K × 8	200 ns	HCMOS	32	Q388
MX23C2048	2M	256K × 8	200 ns	HCMOS	32	Q388
MX23C4096	4M	512K × 8	200 ns	HCMOS	32	Q388

MACRONIX PRODUCT LIST – EPROMs

MX27C64	64K	8K × 8	150 ns	HCMOS	28	Q288
MX27C128	128K	16K × 8	150 ns	HCMOS	28	Q288
MX27C256	256K	32K × 8	150 ns	HCMOS	28	Q288
MX27C512	512K	64K × 8	200 ns	HCMOS	28	Q388
MX27C1024	1M	128K × 8 64K × 16	200 ns	HCMOS	40	Q388

MX

CIRCLE NO 130

tem design techniques using ASICs;" "Software design techniques for innovative PLD architectures;" "Computer-aided software engineering (CASE);" and "Characterization and testing of analog-to-digital converters for digital-signal-processing applications." The last is one of the very few Electro/88 sessions targeted primarily at analog designers.

Thursday's sessions include a number of especially timely topics, such as "RISC technology enters the mainstream," and "Computer backplane interface using high-speed low-power CMOS interface ICs." The session entitled "Simulation of analog and mixed-mode circuits" should attract analog designers, while engineers interested in test-program design are likely to choose "Software tools for test and measurement application-program development." Or you can choose the session "High-integration solutions for personal computer/personal system design" or "Floating-point coprocessors for advanced personal microprocessors."

Good sessions just keep coming

The professional program will still be running at full speed on Thursday afternoon, when the WTC will host the session "Test program generation: extracting tester programs from simulation," and one entitled "Unique software considerations for microcontrollers when listing high-level languages." At the same time, Bayside will be the scene of the sessions "An architectural overview of cache controllers for 32-bit microprocessors" and "Industrial requirements for real-time DSP applications."

To make it easier to choose sessions to attend, Electro's organizers have divided the technical program into "threads," each of which encompasses a group of related sessions. The threads and the numbers of the associated sessions are as follows (tutorials are indicated in italics).

- Electrical, mechanical, and software design process: *2*, 8, 14, *20*, 26, 32, *40*, 43, 47, 49.
- Documentation: *3*, *9*, 15, 44.
- Testability: *21*, 33, 45, 51.
- Release Process: *5*, 11, 17, 29.
- Fabrication: *22*, 28, 34, 52.
- Marketing: *1*, 7, 13, *19*, 25, 37.

This listing of tutorials and technical sessions omits mention of some other Electro/88 events. When you register, you can get information on such events as awards presentations and a seminar on "real-world selling techniques."

So, even if there are no beans in Boston, for EEs there should be no cause for dismay this May. If you want to *know* beans about the state of the art, you can attend Electro/88. It will provide plenty of food for thought. **EDN**

Reference

1. From the song *Boston Beans* by Lee, Raskin, and Schluger. Copyright 1962, Denslow Music Co, Los Angeles, CA. (Incidentally, you can, of course, obtain baked beans in Boston.)

Article Interest Quotient (Circle One)
High 494 Medium 495 Low 496

Museum shows EE memorabilia

No EE should visit Boston without stopping at the Computer Museum. The museum, located at 300 Congress St on Museum Wharf, is only a stone's throw from the World Trade Center (WTC). Go down Northern Ave (where the WTC is located) toward Boston, and turn left on Sleeper St, just before the bridge. The museum will be on your left at the corner of Sleeper St and Congress St. A landmark you can use to spot Museum Wharf is a building shaped like a milk bottle. It's probably best to walk to the museum from the WTC; as one (native Bostonian) EDN staffer puts it, "there's no place to pahk yah cah.

The computer museum chronicles the history of digital technology from a time before the advent of electronics to the present. Exhibits describe such historic computers as ENIAC at the University of Pennsylvania, Mark I at Harvard, Whirlwind I at MIT, TX-0 at Lincoln Lab, and AN/FSQ-7 on the DEW line. More modern machines—including PCs—are covered, too.

The museum is open from 10:00 AM to 5:00 PM Tuesday through Sunday. It stays open later on Fridays. Admission for adults is $4.50; full-time students and children can obtain reduced rates.

FEATURE	BENEFIT
Standards Approval	Meets or exceeds all International standards approvals (UL, VDE, CSA, and TUV)
Product Range	Over 200 standard precision switching power supplies ranging from 25W to 1 KW
Price	Extremely competitive to meet your volume requirements
Warranty	2-year return to factory
Reliability	Consistently achieves less than 1/10th of 1 percent field returns
Size and Performance	Compact size with up to 100 KHz switching speed

It's easy to choose the exact KEC power supply to meet your requirements. Select from over 200 products or have KEC's engineers custom design a precision switching power supply just for you.

Choose from both open frame or modular styles, in a wide range of wattages. You also have a choice of 115 or 230 VAC inputs. KEC assures prompt delivery from its California warehouse.

When you choose a KEC power supply, you get over 70 years of design engineering experience dedicated to creating a standard for you.

Discover the real Multiple Choice in power supplies—Discover KEC!! Write for your FREE literature and information kit, or call KEC toll-free today.

1-800-255-5668

KEC ELECTRONICS, INC.
20817 Western Avenue, Torrance, CA 90501
(213) 320-3902, FAX (213) 618-1197

"KEC—BRINGING MORE POWER TO YOU"

CIRCLE NO 129

Before you tackle EMI shielding problems...

CHECK OUR REFERENCES

A PROGRAM APPROACH TO TEMPEST PROTECTION
PRIVACY: THE ISSUE
TEMPESTITE™ PROGRAMS
A TEMPESTITE PROGRAM MATCHED TO YOUR APPLICATION
TEMPEST EVOLUTION
CHOMERICS
METALKLIP™ Clip-On EMI Gasket
CHO-SEAL™ 1285 CONDUCTIVE ELASTOMER WITH IMPROVED CORROSION RESISTANCE
CHO-CELL™ SHIELD
Conductive Elastomer Gasket Design continued
GASKET MOUNTING
FASTENER REQUIREMENTS
EMI SHIELDING AND GASKET DESIGN
EMI Gaskets Can Be Corrosion Resistant
EMI GASKET BUYERS GUIDE
CHOMERICS

© Chomerics, Inc. 1988

Whether you have a new electronic system to shield, or must retrofit shielding onto an existing system, Chomerics can help.

Just as our EMI shielding products (gaskets, compounds, laminates, vents, and windows) have set the industry's standards for 25 years, so too has the wealth of clearly presented technical information we make available to you. From our comprehensive EMI Shielding Handbook, down to the simplest technical data sheet, you'll get the facts you need to make the best cost/performance choices.

READER'S CHOICE

To assist you in solving your EMI problems, we've organized some key references around major areas of interest. We invite you to circle the corresponding number(s) on the reader service card.

- **Incorporating EMI shielding in your design**
  CIRCLE NO. 39
- **Applications and material selection**
  CIRCLE NO. 40
- **FCC/VDE compliance for commercial equipment**
  CIRCLE NO. 41
- **MIL-SPEC compliance for military systems**
  CIRCLE NO. 42
- **TEMPEST applications**
  CIRCLE NO. 43
- **EMI testing**
  CIRCLE NO. 44

Control
3. Gasket Footprint
CHOMERICS OPTICAL PRODUCTS
CONTRAST ENHANCEMENT FILTERS & SHIELDED WINDOWS
CHOMERICS
APPLICATION UPDATE
APPLICATION UPDATE
Electromagnetic Pulse (EMP) Response Of EMI/RFI Gasket Materials
EMI SHIELDING SOLUTIONS FOR FCC/VDE COMPLIANCE
CHOMERICS

WE PUT AN EMI CONSULTANT ON YOUR DESKTOP.

CHOMERICS
a GRACE company

Chomerics, Inc.
77 Dragon Court
Woburn, MA 01888-4014
Tel: 800-225-1936
(In MA: 617-935-4850)
TWX: 710-393-0173
Fax: 617-933-4318

Chomerics (UK) Ltd.
Unit 8, First Avenue
Globe Park Industrial Estate
Marlow, Bucks., SL7 1YA
ENGLAND
Tel: (06284) 6030
Telex: 849817 CHOMER G
Fax: (06284) 76303

Chomerics GmbH
Postfach 320208
Moltkestrasse 32
4000 Dusseldorf 30,
WEST GERMANY
Tel: 0211/488001
Telex: 8589743 CHOM D
Fax: 0211/483109

Chomerics S.A.
Rue Jacques Brel
Zone Industrielle Les Bellevues
95610 Eragny-sur-Oise
FRANCE
Tel: (1)30.37.63.30
Telex: 608255F CHOMESA
Fax: (1)30.37.46.36

See us at ELECTRO, Booths 1555, 1557

Magnesys Solid-state Memory Subsystems:

Reliable storage for sweltering plants, vibrating factories, critical test labs, dusty quarries, bumpy roads, tossing ships, remote outposts...

Conventional disk drives work fine in most offices. But they can't take the kinds of abuse found in other environments.

Magnesys solid-state memory subsystems can.

These bubble memories stand up to shock, vibration, dust and high and low temperatures because they're non-mechanical and non-volatile. And they don't need batteries.

For design flexibility, the memory subsystems work with a variety of bus structures. Plug-and-play host adapters are available for the PC bus, STD-bus, Multibus* and VMEbus.*

Each subsystem has a 360K or 720K byte data cartridge. And a 3½" or 5¼" half-height electronic drive with embedded SCSI.

Until Magnesys, there were only two ways to get reliable bubble memory subsystems: Build one yourself from a kit and a 290-page instruction manual. Or pay the high price to have a middleman do it for you.

We fabricate our own bubble memories and subsystems right here in America. For a price roughly half what you'd pay for any comparable system.

For reliable data storage at an affordable price, there's nothing like Magnesys solid-state memory subsystems.

Find out for yourself by giving us a call.
(408) 988-1881.

Or write us at Magnesys, 1605 Wyatt Drive,
Santa Clara, CA 95054.

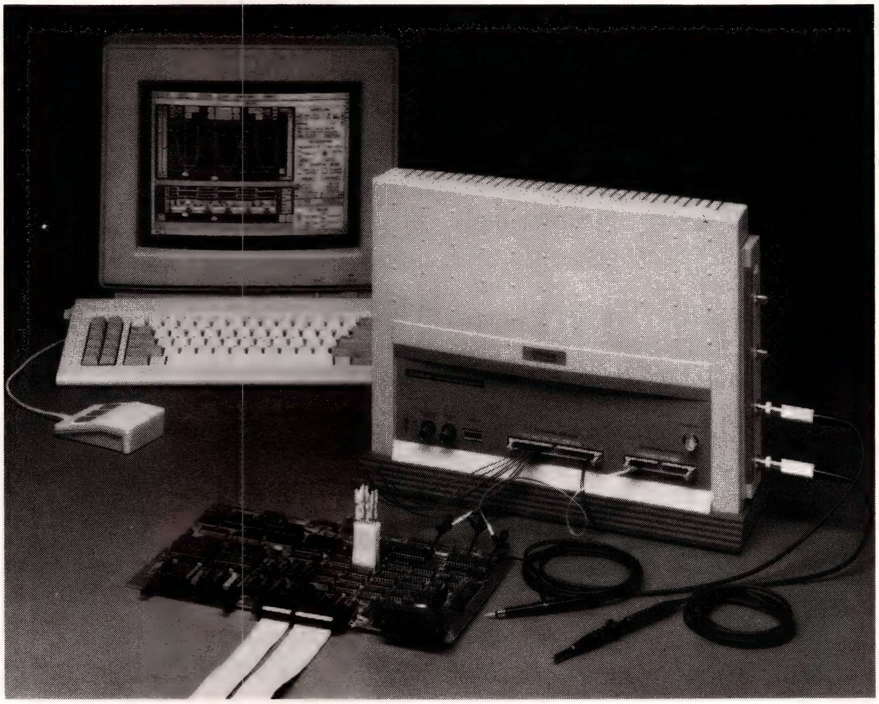
Multibus is a registered trademark of Intel Corp. VMEbus is a trademark of Motorola, Inc.

Magnesys

Reliable storage for an unreliable world.

CIRCLE NO 128

Instrument combines 48-channel LA, 100-MHz DSO, and stimulus generator



The Omnilab 9240 is a combination digital-storage oscilloscope (DSO), logic analyzer (LA), and digital stimulus generator that comes in an attaché-case-sized enclosure. The unit is hosted by an IBM PC, PC/AT, or compatible computer. The scope offers a 100-MHz bandwidth; the 48-channel LA samples at 200M samples/sec.

Unlike separate instruments, the DSO and LA are designed to work in tandem. In combination with a feature named Multiview, the Select trigger system allows you to observe time-correlated analog and digital displays. Select combines the features of scope and logic-analyzer triggering. You can qualify the trigger conditions by use of truth tables stored in RAM, as well as by programming minimum and maximum time delays. Besides letting you see time-correlated displays, Multiview lets you watch digital data alone, analog data alone, or analog and digital displays representing separate time intervals.

Continuous sampling in conjunction with flexible triggering permits the unit to capture and display every occurrence of infrequent events such as missing pulses, metastable states, noise glitches, and bus contentions. From $8900.

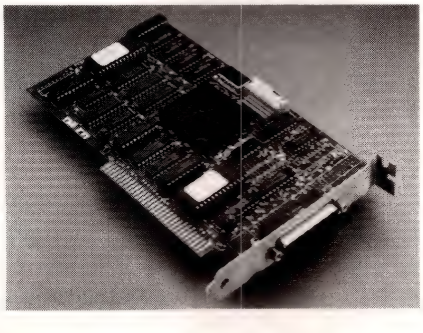
Orion Instruments, 702 Marshall St, Redwood City, CA 94063. Phone (800) 245-8500; in CA, (415) 361-8883. TLX 530942. Booth Nos 2741, 2743, and 2745.

Circle No 530

PC Bus card supports industry-standard graphic formats on flat-panel displays

The PC6424 half-sized card for the IBM PC Bus works in the IBM PC, PC/XT, PC/AT, and compatibles, letting you use electroluminescent panels, ac-plasma panels, and some LCD panels as display devices. The board supports the following standards: the CGA, double-scan CGA, MDA, Hercules graphics card, and 400-line-resolution mode. It can coexist on the PC Bus with other monochrome and color display-adapter cards.

The board contains a BIOS (basic input/output system) ROM that initializes the controller without necessitating the loading of software drivers. The unit is compatible with display matrices of 640×200, 640×400, and 720×350 pixels.



The card includes an interface for the vendor's infrared touch-panel input device. $350 (100).

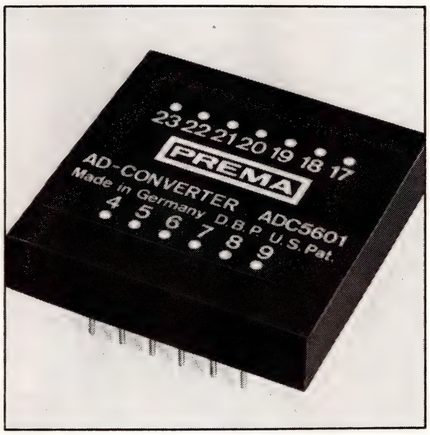
Digital Electronics Corp, 31047 Genstar Rd, Hayward, CA 94544. Phone (415) 471-4700. TLX 172073. Booth No 475.

Circle No 534

Modular analog-to-digital converter offers 25-bit resolution

The 2×2×0.4-in. ADC 5601 uses a proprietary conversion technique to produce a 25-bit result in 20 sec or a 14-bit result in 10 msec. The vendor claims that the conversion technique eliminates charge-transfer errors associated with switching the analog input on and off. When the unit signals that it has completed a conversion, you apply a pulse train to its shift-command input, and the module serially shifts out the conversion result.

You must connect a crystal to provide the module's timing reference and can use crystals that operate from 3.0 to 3.7 MHz to do so. You must also provide a voltage reference in the range of 6 to 8V to a 100-MΩ-impedance input; high-quality, temperature-compensated zener diodes, which have nominal 6.8V outputs, are well-suited to this purpose. By pin strapping, you can configure the unit to accept an input of either 0 to −5V or ±2.5V; the input impedance equals 10 kΩ. After the module has undergone a 5-minute warmup, its temperature coefficient of gain, which is additive to the reference drift, equals <0.8 ppm/°C. The offset drift is <0.6 μV/°C. The nonlinearity is <±1 ppm of full scale. The power required is <600 mW from ±15 and +5V supplies. The power supply rejection typically equals 1 ppm/%V_S. $360.

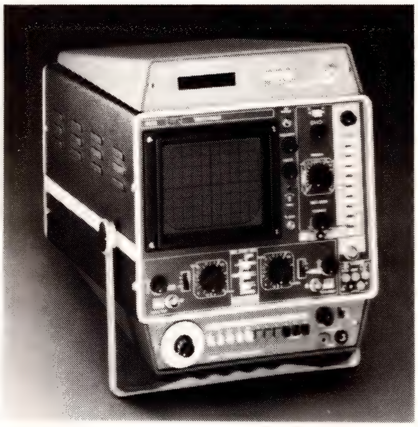


Prema Precision Electronics Inc, 6290 Sunset Blvd, Suite 1126, Los Angeles, CA 90028. Phone (213) 463-2294. Booth No 2811.

Circle No 532

Portable unit includes scope, counter, function generator, and power supplies

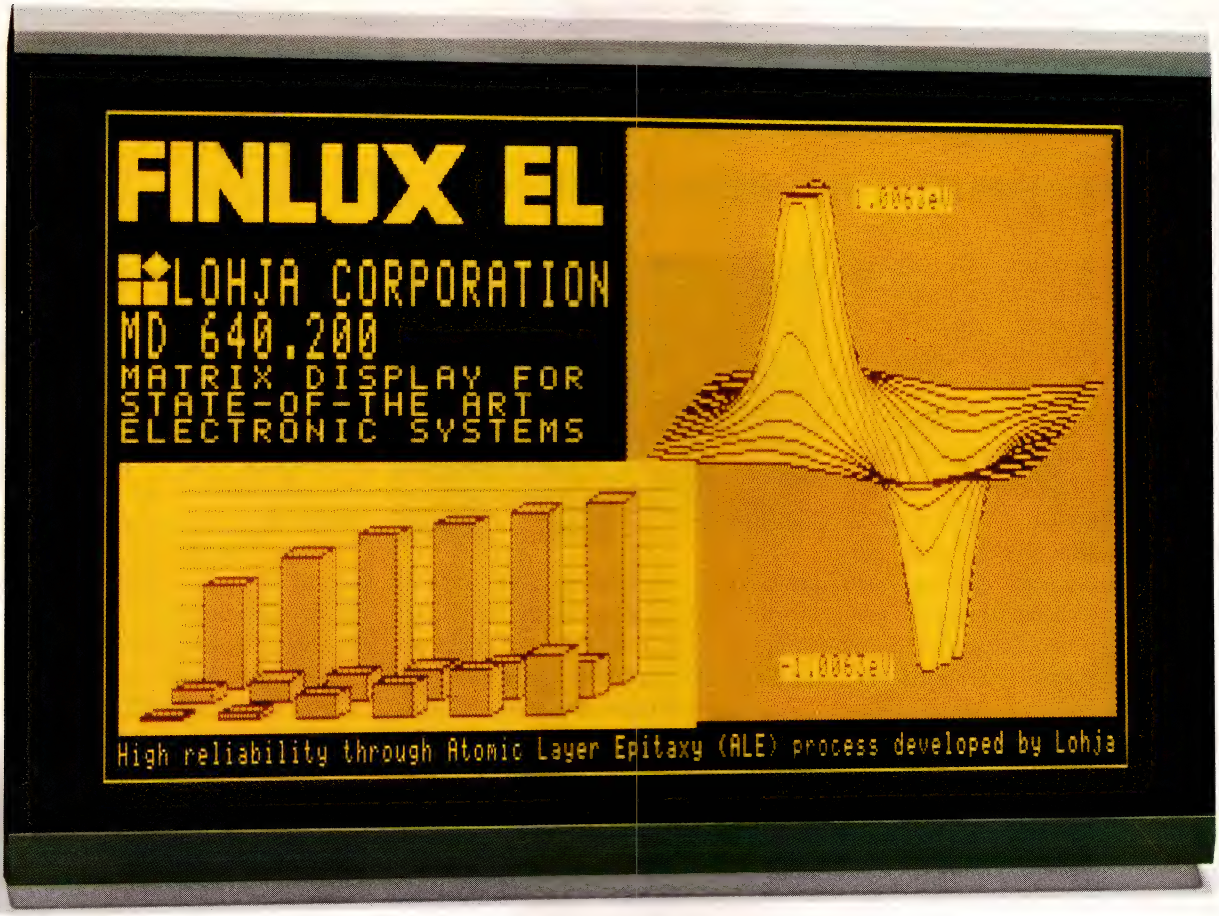
Testation 4444, housed in a 21-lb, 13×11×18-in. package, provides instruments commonly used for the development and testing of low-frequency analog circuits. The unit includes a dual-trace oscilloscope with a 20-MHz bandwidth; a 1-Hz-to-100-kHz function generator that produces sine, square, and triangular waves; a 3-output, regulated power supply that produces 5V at 1A, 12V at 200 mA, and −12V at 200 mA; and a 20-MHz frequency counter with 10-mV-rms maximum-sensitivity inputs that you can connect to the scope or to an external source. The counter's timebase accuracy, which varies no more than ±30 ppm from 0 to 50°C, is ±20 ppm at 25°C.



A 2-channel curve tracer lets you display and compare V/I characteristics of components. The scope has single-ended inputs with a maximum sensitivity of 2 mV/div. You can subtract one channel from the other to provide a differential input. A 5× magnifier provides a maximum sweep speed of 100 nsec/div. A calibrator provides a 200-mV square wave whose amplitude accuracy is ±2%. The function generator produces square and triangular waves whose maximum amplitude is 10V p-p into 600Ω. The maximum sine wave output equals 1.5V rms. A step attenuator reduces the generator's output by 20, 40, or 60 dB. $750.

ET&T Corp, 3001 Redhill Ave, Bldg 1-219, Costa Mesa, CA 92626. Phone (714) 557-2703. TLX 678352. Booth No 2624.

Circle No 531



Give your customers the full picture. With a Finlux EL display.

Take a closer look at Finlux EL flat-panel displays, and you'll see right away why they're just right for your customers.

To begin with, Finlux Matrix Displays help you look your very best—whether you are building process controllers, factory terminals, or electronic instruments. That's because Finlux Displays deliver outstanding picture quality with crisp, stable, and flicker-free images. Which makes them ideal for long stretches of work.

What's more, Finlux Displays offer unmatched reliability because they incorporate a proprietary Atomic Layer Epitaxy (ALE)* process that assures dependable performance in even the toughest industrial environments.

And they're so thin and lightweight, you will appreciate how easy it is to incorporate Finlux Displays into your own system. About half the size of a loose-leaf notebook, Finlux Displays fit into any system where portability counts and space is at a premium.

See for yourself. Call or write Finlux Inc. today. You'll learn how remarkably capable something so remarkably compact can be.

	Input Voltages	Matrix Configuration	Display Area	Size	Weight
MD640.200-20	+5V/ +12V	640x200 pixels	4.8 x 7.68 in. (122 x 195mm)	6.24 in. (158.5mm)H 9 in. (228.5mm)W 1.38 in. (35.0mm)D	16.8 oz. (470g)
MD512.256-39S** 37S 38S	+5V/ +12V +5V/ +15V +5V/ +24V	512 x 256 pixels	3.85 x 7.69 in. (195.2 x 97.7mm)	5.67 in. (140mm)H 10.2 in. (260mm)W 1.38 in. (35.0mm)D	23 oz. (650g)
MD640.400-52	+5V/ +12V	640 x 400 pixels	4.8 x 7.68 in. (122 x 195mm)	6.24 in. (158mm)H 9 in. (228.5mm)W 1.38 in. (35.0mm)D	20 oz. (560g)
MD640.350-60	+5V/ +12V	640 x 350 pixels	4.8 x 7.05 in. (122 x 179mm)	6.24 in. (158mm)H 9 in. (228.5mm)W 1.38 in. (35.0mm)D	20 oz. (560g)
MD320.256-71	+5V/ + 15V	320 x 256 pixels	3.0 x 3.78 in. (76.7 x 96 mm)	4.33 in. (110mm)H 5.12 in. (130mm)W 1.38 in. (35.0mm)D	15 oz. (420g)

*Process developed by Lohja Corporation, Finland

**Extended temp. range version available

FINLUX INC.

FINLUX INC.
20395 Pacifica Drive
Suite 109
Cupertino, CA 95014
Tel. (408) 725-1972
Telecopy (408) 996-7547

Marketing and International Operations:
LOHJA CORPORATION
FINLUX Display Electronics
Box 46
SF-02201 ESP0020
Finland
Tel Int +358 0420 01

Branch Office:
LOHJA CORPORATION
FINLUX Display Electronics
Koshiichi Building 803
Jinjumae 6-19-16
Shibuya-ku Tokyo JAPAN
Tel. Japan 03-797-5425
Telecopy: Japan 03-797-5426

CIRCLE NO 138

Windowing environment for PCs supports control-program development in Basic and C

LabWindows provides an interactive windowing environment for development of control programs on the IBM PC, PS/2, and compatible computers. You can write programs in Microsoft C or in Microsoft QuickBasic. LabWindows features libraries that enable beginners to create control programs for instruments under IEEE-488 bus control. Because many popular instruments are represented in these libraries, you don't need to know the details of how to communicate with your particular instrument in order to create the control programs.

To generate code sequences with LabWindows, you access pull-down menus and select functions by using a mouse or keyboard commands.

LabWindows includes graphics, data-analysis, and data-formatting libraries. The data-analysis library contains routines that perform one- and two-dimensional array arithmetic, scalar and one-dimensional complex arithmetic, and statistical functions. An optional library includes digital signal processing, matrix and vector arithmetic, advanced statistics, and curve-fitting functions. A graphics library includes routines for two-dimensional data plotting, multiple curve plots, and bar charts. An advanced graphics library provides axonometric and contour plots and interactive cursors. The data-formatting library contains routines for converting data among formats, which reduces the time required to program instruments that process data in different formats. Standard package, $495; advanced-graphics and data-analysis libraries, $895.

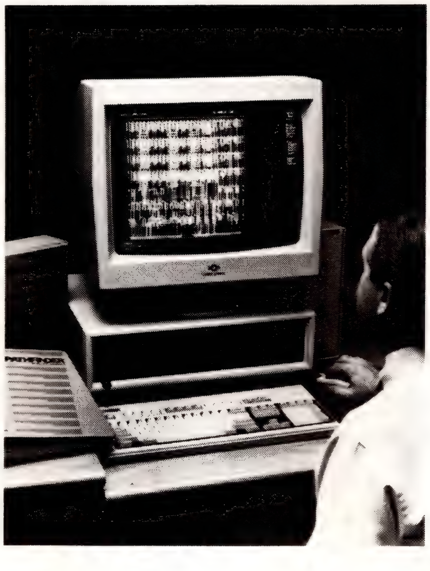
National Instruments Corp, 12019 Technology Blvd, Austin, TX 78727. Phone (800) 531-4742; in TX, (800) 433-3488. TLX 756737. Booth Nos 2803 and 2805.

Circle No 535

Schematic-capture and autorouting software works with popular CAD tool

The Pathfinder pc-board design system consists of a schematic-capture and layout program and an autorouter. Pathfinder works in conjunction with Autodesk Inc's Autocad program to provide mechanical as well as electrical-design capability on IBM PCs, PC/XTs, and PC/ATs. Included in the price of the autorouter is a 32-bit, parallel-processor card with 1M byte of RAM. You install the card in the system unit of the host computer.

The vendor claims that the schematic-capture and layout program places no limitations on board, grid, or schematic size; the number of schematic pages; or the number of parts, part types, pins/part, nets, pad sizes, hole sizes, or board layers. The schematic-capture function can extract net lists from ASCII files, and lets you highlight individual nets.



The autorouter handles 16-layer boards and offers user-redefinable strategies and 45° routes. It is reentrant, operates in single or multiple passes, and supports three algorithms: fast probe, exhaustive search, and rip up and reroute. For each 256k bytes of RAM on the coprocessor board, the autorouter can handle a board area of approximately 56 in.^{2} and as many as 89,600 pins. Schematic capture and layout, $1995; autorouter, $2995.

Bishop Graphics CAD Systems Corp, Box 5007, Westlake Village, CA 91359. Phone (818) 991-2600. TLX 662400. Booth Nos 2356 and 2358.

Circle No 533

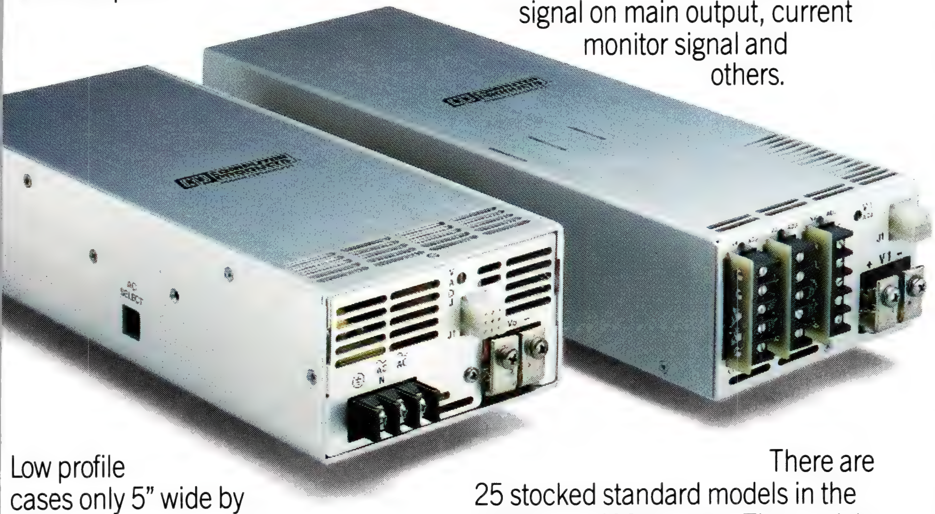
COMPUTER PRODUCTS
POWER CONVERSION

POWER *Briefs*

COMPACT 250 & 400 WATT SWITCHERS FEATURE FOUR-OUTPUT PARALLELING

The PPM and PFS Series 250 and 400 Watt cased switchers incorporate a unique closed-loop current sharing control circuit which permits simultaneous paralleling of up to four outputs, each with remote sensing. In addition, a single-point failure protection circuit assures that a single failure in a redundant power system will not cause the power bus to fail.

The series can provide as many as seven outputs.



Low profile cases only 5" wide by 2.75" high permit convenient stacking of the supplies. Power density is up to 2.4 Watts per cubic inch, and all models are efficiently cooled by a miniature internal ball bearing DC fan.

These switchers employ a bridge-driven forward converter using 100kHz MOSFET switching. The auxiliary outputs have either linear or magnetic amplifier regulation and are incorporated in three plug-in modules. Control circuitry is fabricated on a single circuit board using surface-mount technology. Standard features include switch selectable 115/230 VAC input, input line filter, remote on/off, power good signal, remote sensing, thermal protection with warning signal, overload protection, overvoltage protection, soft start and inrush current limiting. Optional features include current sharing, OVP crowbar and DC OK signal on main output, current monitor signal and others.

There are 25 stocked standard models in the 250W and 400W series. The models are UL recognized, CSA certified, and TUV approved.

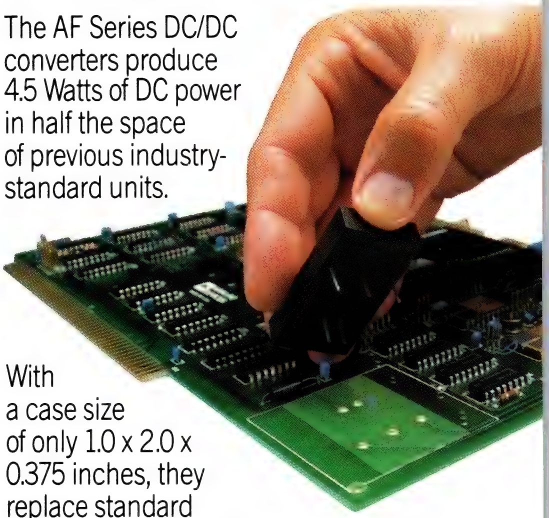
Key Specifications:

Line Regulation	0.2%
Load Regulation	0.2%
Holdup Time	30 msec. min.
Efficiency	70 to 85%
Oper. Temp. Range	0° to 65°C

From Computer Products/Power Products **Circle No. 1**

NEW 4.5 WATT DC/DCs NEED ONLY HALF THE SPACE

The AF Series DC/DC converters produce 4.5 Watts of DC power in half the space of previous industry-standard units.



With a case size of only 1.0 x 2.0 x 0.375 inches, they replace standard 2 x 2 inch converters, yet have the same pinouts.

This series is fabricated with surface-mounted components on a miniature thick-film substrate to achieve 6 watts per cubic inch power density and efficiencies up to 66%. Available in single (+5, +12 or +15V) and dual (±12V or ±15V) outputs, the input voltage can be either +5 or +12VDC

Other key specifications include ±1.0% line regulation, 0.5% load regulation, and 40mV p-p ripple and noise. These converters are ideal for board-mounted applications in computers, I/O boards, telecommunications, process control and scientific instruments. The AF Series is on distributor shelves now.

From Computer Products/ Stevens-Arnold

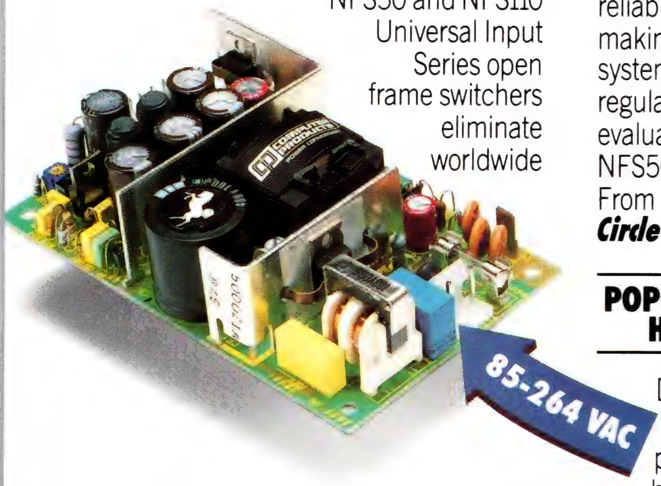
Circle No. 2

© Computer Products Incorporated, 1988

Your Partner in Power

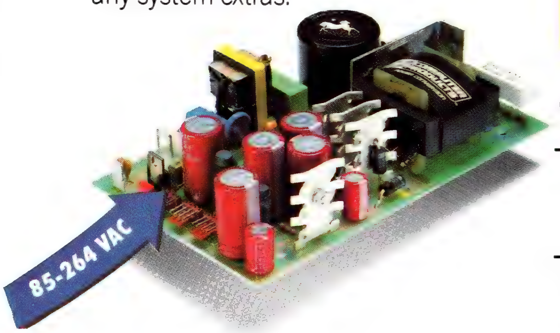
UNIVERSAL INPUT SWITCHERS OPERATE FROM 85 TO 264 VAC

Operate from any line voltage from 85 to 264 VAC without changing jumper wires or switches. Computer Products/Boschert's new NFS40, NFS50 and NFS110 Universal Input Series open frame switchers eliminate worldwide line voltage selection problems and offer system design flexibility.



On the low end, the NFS40 series of single and multiple output 40 watt switchers measures a tiny 5" x 3" x 1.2". These switchers provide more than 2.2 watts/cubic inch, and will fit into very small spaces.

The NFS50-7608 50 watt switcher directly replaces the industry standard 6.3" x 3.9" 40 watt unit. No need to mechanically redesign. Just drop it in and enjoy the benefits of universal input, plus 10 additional watts for any system extras.



For small to medium systems, check out the NFS110 series 110 watt switchers. The +12V output will deliver up to 9 amps to start disk drives. The small 7.0" x 4.25" x 1.8" size delivers more than 2.0 watts per cubic inch.

All of these switchers will operate reliably with no load on the output, making them ideal for expansion systems. Also, each output is fully regulated. NFS40 and NFS110 evaluation units are now available. NFS50 is in distribution.

From Computer Products/Boschert
Circle No. 3

POPULAR DC/DC CONVERTERS HAVE NEW LOW PRICES

Design in high performance and reliable operation at new low prices. The ES, EA and H series have filled a lot of PC boards to date but never so economically. Prices have been reduced by 10% for the ES series and 15% for the H and EA series. Also, the H and EA series are available in new 1.0 x 2.0 x 0.38 inch non-conductive packages. Check the table below and send for the latest data on our top performers. Or better yet, call your distributor for these low cost solutions.

Series	Output Power	Output Type	Input Voltage	Output
H	1 Watt	Single	5, 24, 48V	±5V @ 200mA
EA	1.8 Watts	Dual	5V	±12 or ±15V @ 60mA
ES	15 Watts	Triple	12, 24, 48V	+5V & ±12V +5V & ±15V or ±5V & +12V

From Computer Products/Stevens-Arnold
Circle No. 4

TAKING THE RISK OUT OF CUSTOM OPEN FRAME SWITCHERS

Computer Products/Boschert can take the risk out of custom switcher development. You get a predictable, highly reliable switcher, based on our well-known standard circuits.

Here's why:

Field-Proven Building Blocks. The quickest, least expensive way to build a custom switcher is using existing circuits. Computer Products/Boschert has hundreds of building blocks, field proven over our 15 year history. We understand their use and limitations. Your custom design is predictable, economical and virtually risk-free.

Appropriate Topology. Using the wrong topology is either costly or unreliable. Since we understand and build virtually every type of switcher, there is no need to squeeze your custom needs into our favorite topology. You get the correct topology for your power requirement.

Experience. Your supply is built by a company exclusively dedicated to switchers for 15 years. Our ability to integrate electrical, mechanical and thermal designs is exceptional. Our new medium power designs deliver more than 2 watts/cubic inch. The result is a highly compact switcher that meets or exceeds your system requirements.

Safety Approval. UL and CSA usually take no more than eight weeks. Full VDE certification usually takes only 12 to 16 weeks after your final prototype approval. TUV approval is also available.

Manufacturability. Every supply we make is designed with manufacturability in mind. We use a common parts base, with well characterized components that meet our conservative stress derating guidelines. Check for further information on custom switchers.

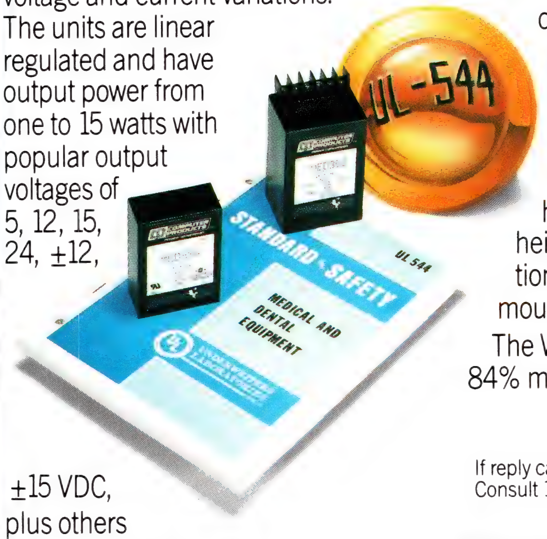
From Computer Products/Boschert
Circle No. 5

POWER *Briefs* No. 1

LINEAR POWER MODULES MEET UL544 MEDICAL REQUIREMENTS

For UL544 approval you can rely on Computer Products/Power Products new MED 300/500 Series of AC/DC encapsulated power modules. They meet or exceed the stringent UL544 requirements for medical equipment. These supplies are recommended for use in non-patient contact medical, dental and laboratory applications where high isolation and low leakage are critical.

The MED 300/500 series is provided in single, dual and triple output models offering 63 different output voltage and current variations. The units are linear regulated and have output power from one to 15 watts with popular output voltages of 5, 12, 15, 24, ±12, ±15 VDC, plus others available. Standard protection features such as overtemperature, overload and short circuit protection are included.

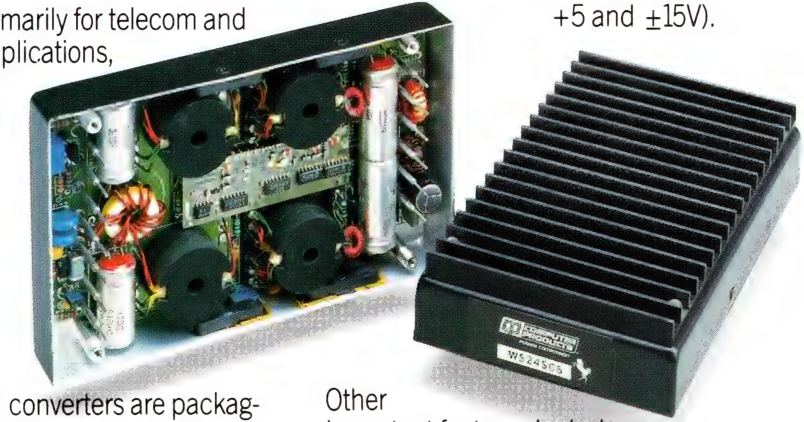


The power modules incorporate a split-bobbin wound transformer which provides high isolation between primary and secondary with low coupling capacitance. This results in 2500 VAC isolation voltage and less than 10uA leakage current.

The units are available in either printed circuit mountable or chassis mountable packages. In addition to UL544 approval the series is CSA certified.

From Computer Products/ Power Products ***Circle No. 6***

100 WATT DC/DC CONVERTERS HAVE LOW PROFILES, HIGH EFFICIENCIES



Designed primarily for telecom and computer applications, the new WS Series from Computer Products/ Stevens-Arnold offers 100 watts with single, dual, and triple outputs. The converters are packaged in a low profile case (3.5 x 5.5 x 0.91 inches) producing a power density of 5.7 watts per cubic inch. Available in chassis mount with screw terminations or printed circuit board mounting. The PCB mount version is supplied with a heat sink (adds 0.35 inches to height) which allow for conventional cooling with *no* special mounting required.

The WS Series has an efficiency of 84% minimum and a 2:1 input range of either 18 to 36 VDC or 36 to 72 VDC Output ranges supplied are single (+5, +12 or +15V), dual (+5 and +12V), or triple (+5 and ±12V, +5 and ±15V).

Other important features include 500 VDC isolation, input surge protection, reverse voltage protection and remote on/off control with idle currents down to 10mA.

Key Specifications:

Line Regulation . . . . . . ±0.5% max.
Load Regulation . . 2.0% (to no load)
Ripple and Noise . . 100mV p-p max.

This series is available through distribution.

From Computer Products/Stevens-Arnold
Circle No. 7

If reply card is missing, please circle reader service number.
Consult 1987/88 EEM, page 643 for local sales office or call (305) 974-5500, Ext. 7514.

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS MAIL PERMIT NO. 251 POMPANO BEACH, FLORIDA

POSTAGE WILL BE PAID BY ADDRESSEE

COMPUTER PRODUCTS®
POWER CONVERSION

2900 GATEWAY DRIVE
POMPANO BEACH, FL 33069-9944

POWER *Briefs* No.

UP TO 591,000 HOURS MTBF WITH OPEN FRAME LINEARS

Step up to higher standards of reliabilty with the World-Standard Series of open frame linears.

The aluminum frames and power ratings of the World-Standard Series are form, fit, and function replacements for all other open frame linear power supply manufacturers.

With four different AC input line voltage ranges, these supplies can be connected for use in any country of the world.

These units have a VDE construction power transformer with enclosed split- bobbin windings and 3750 VAC minimum isolation.

The designs are conservative with efficiencies up to 60% and all power supplies receive a four-hour burn-in before shipment.

Other features include current-limiting short circuit protection on all outputs, overvoltage crowbar on 5V outputs, remote sensing on single outputs and the 5V output of triples, reverse voltage protection on all outputs, and operation from 0°C to 50°C with no derating. The World-Standard Series (PL Series) are UL recognized, CSA certified, and TUV approved.

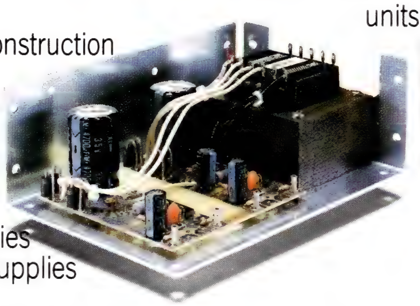
Custom versions of this series are also available with outputs from 2 to 32VDC and output power levels of 15 to 150 watts. Your local Computer Products distributor has units available now.

From Computer Products/Power Products
Circle No. 8

TYPICAL CALCULATED MTBFs

Output Voltage[1]	Output Current	MTBF[2]
5V	3.0A	**591,533** hrs
12V	6.8A	**417,240** hrs
15V	6.0A	**420,943** hrs
24V	4.8A	**328,798** hrs
5V/±12V	3A/±1.0A	**261,201** hrs

[1] Consult factory for additional models.
[2] Calculations per MIL-HDBK-217E @ 100% load; 115 VAC line; 25° C ambient temperature; ground, benign



If reply card is missing, please circle reader service number.
Consult 1987/88 EEM, page 643 for local sales office or call (305) 974-5500, Ext. 7514.

MIL-SPEC POWER SUPPLIES FOR RUGGED ENVIRONMENTS

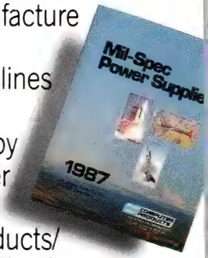
From missiles to submarines Computer Products/ Tecnetics has been solving Mil-Spec problems for over thirty years.

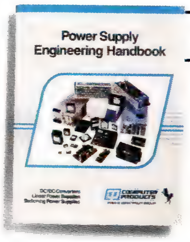
Specialists in Mil-Spec AC/DC power supplies and DC/DC converters, Computer Products/ Tecnetics has participated in many major military programs including F-16, Tomahawk, EA-6B, MSE and E2-C.

From state-of-the-art topologies to advanced package design, every attention is paid to cost-effective custom designs for demanding environmental requirements. Let us modify an existing standard product or develop a totally new design to meet your system specifications. We are certified to manufacture to Mil-Q-9858A and conform to the guidelines of NAVMAT P4855-1.

Send for you free copy of our Mil-Spec Power Supply catalog.

From Computer Products/ Tecnetics ***Circle No. 9***





FREE!

Send for your free copy of our Power Supply Engineering Handbook providing specifications for our complete line of power supplies with power ranges from 1/2 Watt to 1500 Watts.
Circle No. 10

QUICK ACTION REPLY CARD

PLEASE SEND:

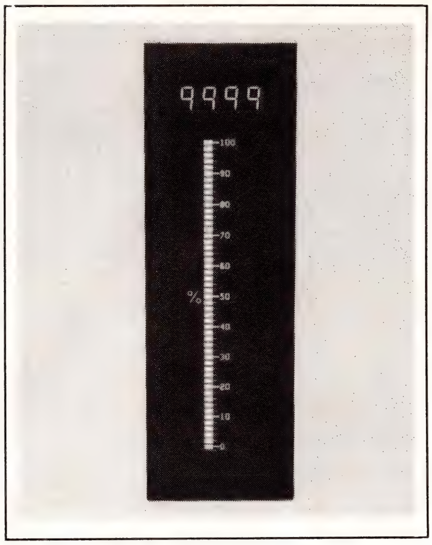
1. PPM/PFS Series
2. AF Series
3. NFS 40/50/110 Series
4. ES/EA/H Series
5. Custom Switchers
6. MED Series
7. WS Series
8. World-Standard Series
9. Mil-Spec Catalog
10. Engineering Handbook
11. Have an Applications Engineer Call
12. Have a Sales Person Call

Name ______________________ Title __________
Company ______________________ Dept/MS __________
Street ______________________
City ______________ State __________ Zip __________
Telephone (   ) ______________ EDN

COMPUTER PRODUCTS
POWER CONVERSION

(305) 974-5500

Your Partner in Power

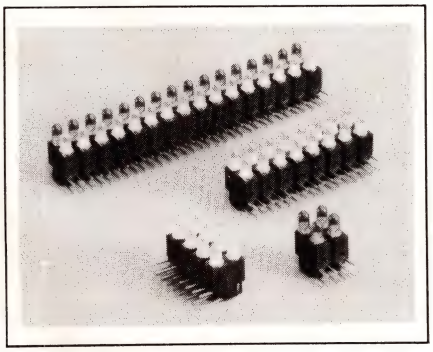


BAR GRAPH

The Model K051 51-segment LED-array bar graph features an analog bar that follows the level of an analog input signal with a response time of 55 msec. Simultaneously, a 4-digit readout displays the signal-input level with 0.1% accuracy. The unit measures 11.5×3.5 in. You mount it through a front panel cutout and secure it with two adjustable retaining clips. The unit comes with a 110/220V ac power supply mounted on it. The standard unit features red LEDs; you can obtain amber, green, and multicolored LEDs as options. $400. Delivery, eight to 10 weeks ARO.

Dixson Inc, Box 1449, Grand Junction, CO 81502. Phone (303) 242-8863. TWX 910-929-6991. Booth Nos 2203 and 2205.

Circle No 536

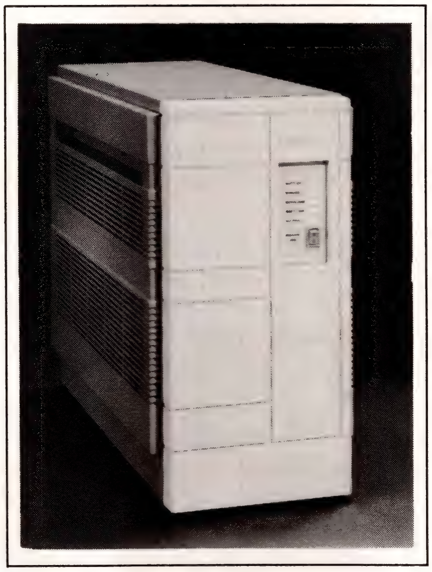


LED ARRAYS

T-1 LED arrays are arranged in single- or double-row packages for right-angle mounting on a pc board. The preassembled LEDs come in blocks of 1, 2, 4, 8, and 16 to save assembly time. The blocks are arranged on a 2.54-mm pitch according to DIN 41494 requirements. The LEDs have a maximum installed height of .41 in., feature tinned terminals, require no mounting hardware, and operate over −40 to +85°C. They come in red, green, and yellow. The double-row packages provide such combinations as red/red, green/green, yellow/yellow, red/yellow, red/green, and yellow/green. From $0.50.

Elma Electronic Inc, 41440 Christy St, Fremont CA 94538. Phone (415) 656-3400. FAX 415-656-3783. Booth Nos 2650 and 2652.

Circle No 537

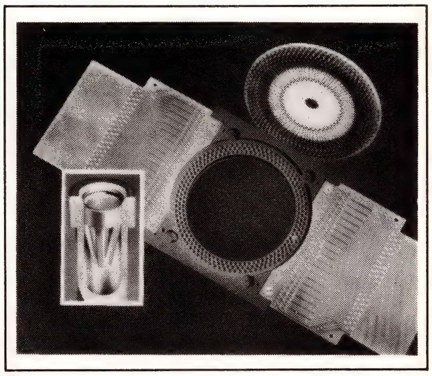


POWER SOURCE

The SPS/R standby power source features a 1-msec transfer time. When operating from ac power, a regulator, whose efficiency is 95%, passes the input sine wave through with less than 1% distortion. The regulator maintains the output voltage within +5 to −8% in the event of ac-input-voltage variations from +15 to −25%. If the input voltage falls below −25%, the unit shifts to inverter/battery power and supplies an output voltage within ±2% of nominal, with less than 5% harmonic distortion. When the ac power returns to within −25% of its normal level, the unit shifts power back to the ac input with no breaks at the zero-voltage crossing. You can order 60-Hz units, with 120V ac input/output voltages, rated for 500, 1000, or 1500 VA. $1445.

Sola, 1717 Busse Rd, Elk Grove Village, IL 60007. Phone (312) 439-2800. TLX 280538. Booth No 2703.

Circle No 539



RECEPTACLE

You can insert the 0300 6-finger receptacle with relatively little force. For example, when used in a circular probe card, the receptacle requires only 34 lb of insertion force. Its funnel-shaped design reduces the possibility of misalignment. This suits the device to applications that entail repeated plugging and unplugging. The device features a shell constructed of brass alloy 360 and contacts made of beryllium copper alloy 172. You can obtain a 0.320- or 0.397-in.-long receptacle. The device is suited for use with the vendor's 3137 pin. $0.08 (10,000).

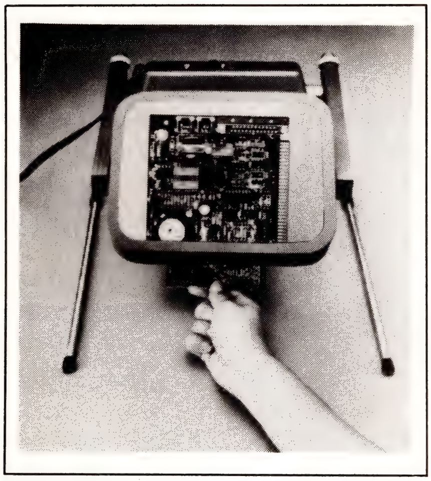
Mill-Max Mfg Corp, Box 300, 190 Pine Hollow Rd, Oyster Bay, NY 11771. Phone (516) 922-6000. TWX 510-221-1820. Booth Nos 1069 and 1071.

Circle No 538

MAGNIFIER

The MasterLens Illuminated Stereo Magnifier features a 6×8-in. rectangular glass lens that provides an

– Circle 100 for COMPUTER PRODUCTS



extralarge viewing field. The unit causes less than 2% distortion and can provide magnification of more than 3 diopters, depending on the focal length. There is sufficient depth of field under the lens to allow free hand movement. You can rotate the lens and a fluorescent lighting system to obtain the best viewing angle. Model STV-1, with portable stand, $299; model STV-2, with retractable arm, $389.

Contact East Inc, Box 786, North Andover, MA 01845. Phone (617) 682-2000. TLX 383088. Booth No 206.

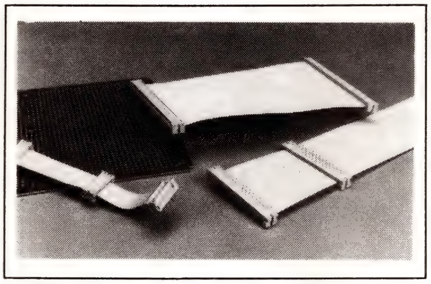
Circle No 540

TRIMMER CAPACITORS

Surftrim surface-mounted trimmer capacitors are suited to vapor-phase reflow soldering. The vendor offers them unsealed or in sealed membranes that protect them against contaminents. You can obtain the unsealed devices in 3.2×4.5×2.8-mm carrier-and-reel packages and the sealed devices in 4.0×4.5×2.8-mm carrier-and-reel packages. The vendor offers the devices with eight capacitance ranges from 1.7 to 60 pF. The capacitors operate over −25 to +85°C. They are rated at 100V dc, feature 220V dc dielectric withstanding voltage, and provide insulation resistance of 10^4 MΩ min at 100V dc. $0.36 (10,000).

Sprague-Goodman Electronics Inc, 134 Fulton Ave, Garden City Park, NY 11040. Phone (516) 746-1385. TLX 144533. Booth No 218.

Circle No 541



CONNECTORS

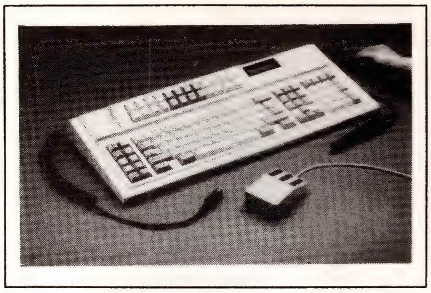
You can permanently attach LAT-CON 2-row transition, .050-in. flat-cable connectors to pc boards, eliminating the need for headers. They come with preassembled sockets and covers, but open on one end for lateral cable insertion. The vendor offers the connectors for 10 to 64 circuits with .100-in. row spacing. You can obtain them with either 0.118-in. or 0.157-in. solder pins, plated with 315 μin. of tin. From $0.53 to $3.67.

Panduit Corp, 17301 Ridgeland Ave, Tinley Park, IL 60477. Phone (312) 532-1800. Booth Nos 342, 343, 348, and 349.

Circle No 542

KEYBOARD

The G80-2000 multi-option keyboard is IBM compatible. Its layout is identical to that of the IBM 3270 keyboard, with 10 function keys on its left end and another 24 arranged in two rows along its top. The keyboard comes with an enhanced version of SmartKey that provides an extra 96 functions by permitting each function key to function alone, and when shifted, control-shifted, or ALT-shifted. A liquid crystal display provides operator guidance. The 123-key keyboard, equipped with electronic options for bar-code reading, the installation of a mouse, and the use of a magnetic-card reader, costs $765. Bar-code reader, $170; light pen, $45; and mouse, $45.



Cherry Corp, 3600 Sunset Ave, Waukegan, IL 60087. Phone (312) 360-3585. Booth Nos 1431, 1433, 1435, 1437, and 1439.

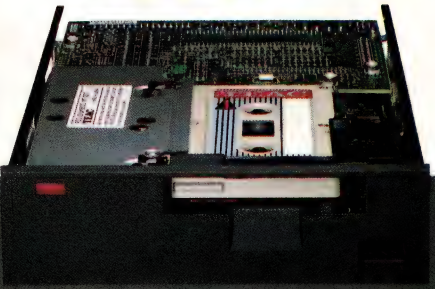
Circle No 543

LOGIC BOARDS

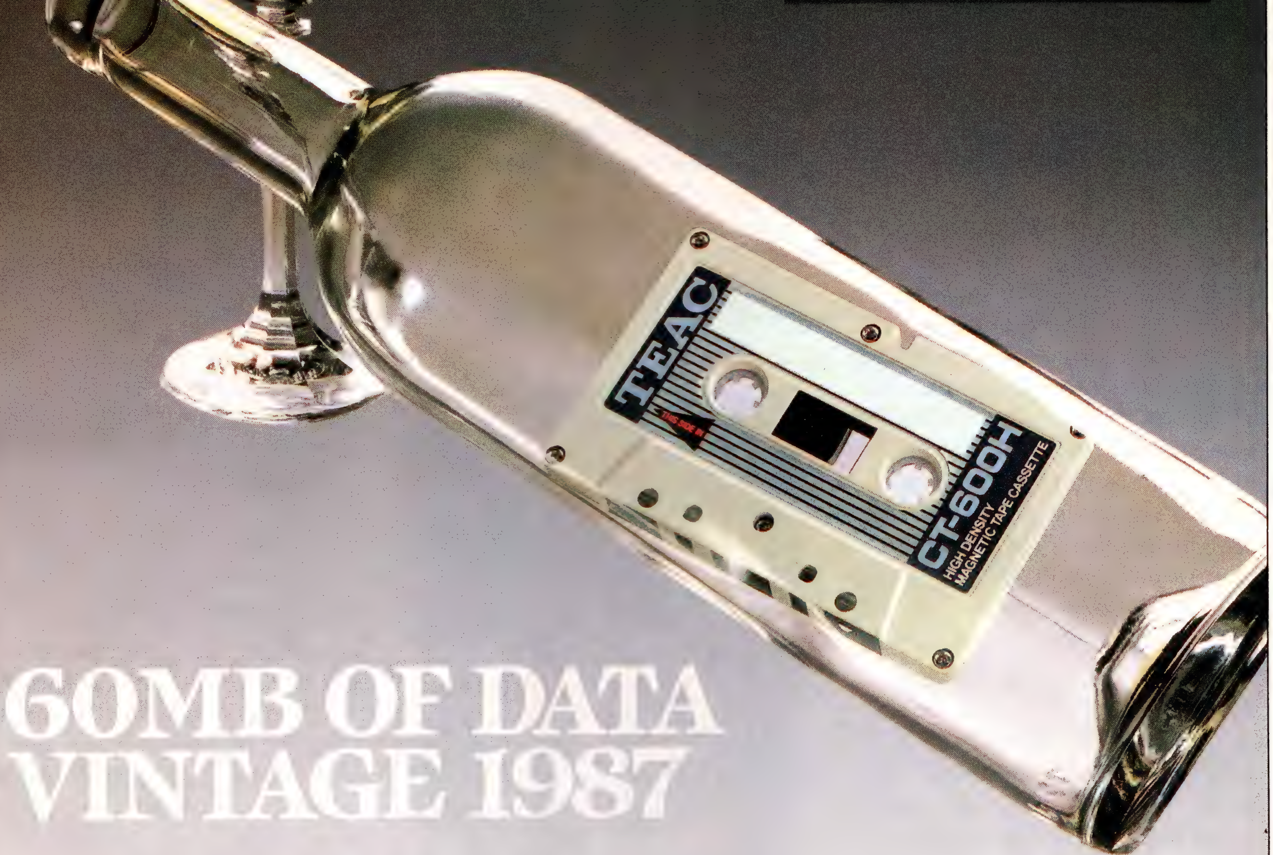
Metric Series wire-wrap logic boards come in Eurocard sizes ranging from 3U×160 to 9U×400 mm. They are available with power and ground for the VME Bus, Multibus II, and IEEE 896 Futurebus, or in uncommitted versions for special development. The low-noise boards feature SMT decoupling capacitors throughout the board. You can obtain the boards in a variety of pin patterns, including a low-density universal DIP mounting, a high-density universal DIP mounting with vertical pin loading, a high-density universal DIP mounting with vertical and horizontal pin loading, and a hybrid pin grid array and universal DIP mounting with vertical or vertical and horizontal pin loading. Depending on its pin pattern, a 3U×160-mm board can cost as little as $155 and a 9U×400-mm board can cost as much as $1592.

Standard Logic Inc, 4940-A E La Palma Ave, Anaheim, CA 92807. Phone (714) 779-2897. Booth No 2137.

Circle No 544



HALF-HEIGHT DIGITAL CASSETTE DATA STREAMERS: AN IDEA WHOSE TIME HAS COME



FAST, SIMPLE AND RELIABLE BACKUP WITH INTERCHANGEABLE MEDIA

Every year is a "vintage" when it comes to hard disk backup. No one can afford to have 60MB of data go sour. Use the TEAC MT-2ST data streamer for day-to-day backup or archival storage. Data cassettes are rugged, compact, ultrareliable, and cost-competitive. Direct reel drive enables precise speed/positional control without time-consuming media preformatting. Store anything from a single file to entire disk image under DMA control. And do it in 4 minutes (20MB), 10 (50MB) or 12 (60MB).

Full media compatibility means that complete data bases can be sent through the mail. D/CAS-05 (QIC-02), SCSI, or D/CAS-15 (QIC-36) interfaces available. Built-in data formatter for excellent space factor.

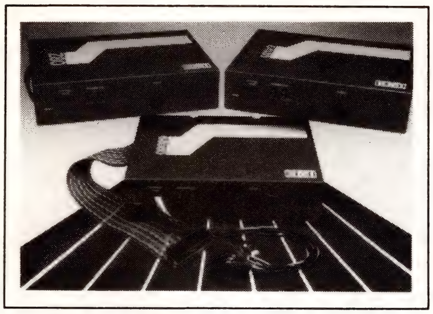
TEAC® For Memories You'll Be Glad To Have

TEAC CORPORATION: 3-7-3 NAKA-CHO, MUSASHINO, TOKYO, JAPAN
TEL: (0422) 53-1111 TLX: 2822451 FAX: (0422) 55-2554

■ **Hong Kong,** Nissei Sangyo Co. Ltd. Hong Kong Branch tel: 3-343441-6; KARIN ELECTRONIC SUPPLIES CO., LTD. tel: 3-898252 ■ **Singapore,** Nissei Sangyo Pte. Ltd. tel: 65-7372011; UAC CORPORATION tel: 7450082 ■ **New Zealand,** Northrop Instruments & Systems Ltd tel: 856-658 ■ **Australia,** Electrical Equipment Limited tel: 888-9000 ■ **Indonesia,** CHUGAI BOYEKI CO. LTD. tel: 370824 ■ **Philippines,** COMPEX INTERNATIONAL INC. tel: 213020 ■ **India,** Priya Electronics & Chemicals Limited tel: 2863611 ■ **Kuwait,** Bader Al Mulla & Brothers Co. W.L.L. tel: 2423250 ■ **South Africa,** EPSIDON TECHNOLOGY (PTY) LTD. tel: (011) 787-1030/33 ■ **United Kingdom,** TEKDATA LIMITED tel: 0782 813631 ■ **F.R. Germany,** nbn Elektronik GmbH tel: 08152/390 ■ **Austria,** nbn Elektronik GmbH tel: 04762/5444 ■ **Netherlands,** SIMAC ELECTRONICS B.V. tel: 040-582911 ■ **Belgium and Luxemburg,** SIMAC ELECTRONICS SPRL/PVBA tel: 02-219.24.53 ■ **France,** TEKELEC AIRTRONIC S.A. tel: (1) 4534-75-35 ■ **Italy,** A.E.S.S.E. S.p.A tel: 02-54.64.741-2-3 ■ **Spain,** ATAIO Instrumentos S.A. tel: 733 05 62 ■ **Switzerland,** WENGER PERIPHERALS AG tel: 01/830 75 55 ■ **Denmark,** Dansk Binær Teknik A/S tel: 03-662020 ■ **Sweden,** MACROTEK AB tel: 08-733 02 20 ■ **Norway,** SCANTELE AS tel: (2) 65 69 20 ■ **Finland,** INSTRUMENTARIUM ELEKTRONIIKKA tel: 0-5284350

** If no distributor is listed above in your area, please contact us directly for further details about our products.*

CIRCLE NO 180

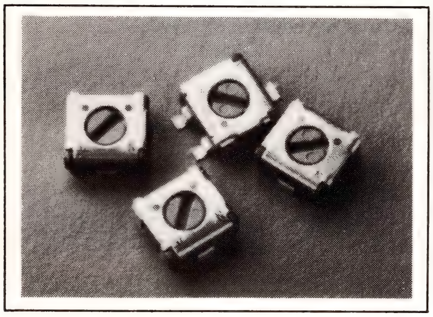


EMULATORS

The HMI-200 Series of in-circuit emulators now includes units that support the 8051/8031 family (including the Oki 80C59 Series), the 68HC11, the 6809, and the 8085. All units include two 72-bit×4k-frame trace buffers, logic-analyzer features, a general-purpose interval timer, and advanced break- and trigger-point parameters. The 6809 and 8085 emulators allow bank selection within emulation memory. They can also track the target system's bank selection mechanism. The 8051 emulator can trace all four of the microcontroller's ports in addition to address, data, and status values. This emulator can also use bit patterns on the 8051's 16 TTL inputs to qualify break and trigger conditions. The 68HC11 unit supports all of the μC's modes. $4750.

Huntsville Microsystems Inc, Box 12415, Huntsville, AL 35082. Phone (205) 881-6005. Booth No 2596 and 2598.

Circle No 564

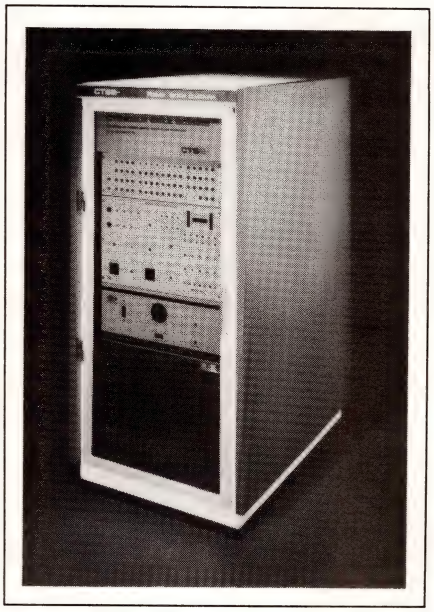


ROTARY SWITCH

The surface-mount CS-4 spdt selector switch has a 4.5×5-mm outline. For a dc resistive load, the contact rating equals 0.5 VA; the maximum voltage and current ratings equal 16V and 100 mA from −25 to +70°C. A high-temperature housing material allows the switch to survive IR and vapor-phase soldering processes for five minutes. The switch can also withstand immersion-type cleaning processes, even with the use of low-viscosity liquids. The rotational life and total rotational angle spec at 20 cycles and 90°, respectively. The units are available in J-hook and gull-wing styles in bulk or in tape-and-reel packaging. $0.50 (5000).

Mepcopal Co, 11468 Sorrento Valley Rd, San Diego, CA 92121. Phone (619) 453-0332. Booth No 1349.

Circle No 553

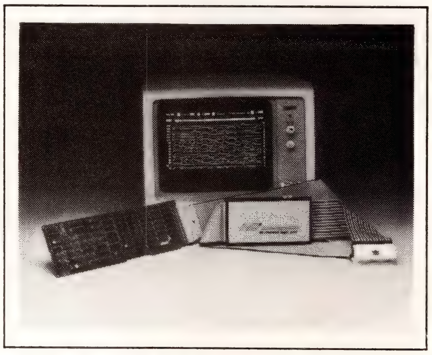


ENCLOSURES

The MVE line of knock-down vertical enclosures offers the strength and rigidity of welded enclosures. These easy-to-assemble units are made of 13-gauge, cold-rolled steel and feature an EPA-approved, textured acrylic-enamel finish. The enclosures' strength and rigidity come from the design of their corners. A heavy-gauge mounting plate is welded into the top of each corner post. This plate is recessed into the columns. When the assembler tightens the corner bolt, the plate and the contact area of the cabinet frame deflect, forming a broad contact surface. The corner joints' tab-and-slot construction also guarantees correct assembly. The corner posts are always in the proper position for side-panel and door mounting. The MVE line includes models that are 42, 61, and 70 in. high, 25 or 30 in. deep, and 19 in. wide. From $520 to $670.

Precision Fabrication Technologies Inc, Highway 16 W, Monon, IN 47959. Phone (800) 558-7297; in IN, (219) 253-6666. Booth No 2769.

Circle No 547



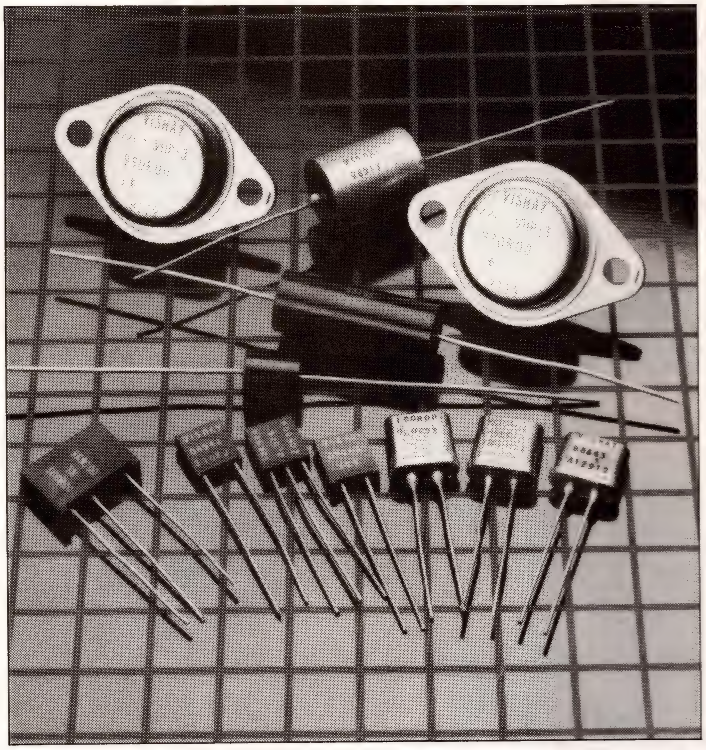
LOGIC ANALYZER

The PA480 logic analyzer is built on an IBM PC bus card. Disassembler pods are available for the 68000 and Z80 μPs. General-purpose pods support 48 channels at 25 MHz and 12 channels at 100 MHz. Using an internal clock, the 100-MHz pod can sample at 100-, 50-, 10-, 5-, 1-, 0.5- and 0.1 MHz. It will also sample at twice the frequency of a 50% duty-cycle external clock. The pod has one fixed TTL threshold plus two variable thresholds—one for even-numbered channels, the other for odd-numbered channels. You can set the variable thresholds from −5V to +5V. Four of the channels have glitch detection; they can detect glitches whose width at the threshold is 5 nsec or more. PA480, $1595; general-purpose pods, $350; 16-bit disassembly pods, $695; 8-bit disassembly pods, $495.

NCI, Box 11025, Huntsville, AL 35814. Phone (205) 837-6667. Booth No 2936.

Circle No 563

The Leaders in Precision Resistor Technology



Whichever way you judge us, Vishay is the first choice for precision resistors, and has been for 25 years, wherever outstanding performance is critical to success.

We are No.1 for choice.

Bulk Foil: Discrete resistors, Networks, Dividers, Trimmers, Potentiometers, Hybrid Circuit Chips, Custom Devices, Power Resistors. **Wirewound:** Precision, Low Cost, Silicone Coated Power. **Thick Film:** High Voltage, Chip. **Metal Film:** Glass, Encapsulated, MIL, Commercial. **Thin Film:** Custom Designed SIPs, DIL, and Chips.

No.1 for availability, to provide you with what you want when you want, 10 days delivery even for non-standards.

No.1 for customer support, including outstanding applications know-how, a first class prototype service, and minimal set-up costs.

No.1 for service. And, of course, No.1 for outstanding product performance.

Telephone and we will tell you whatever you need to know to prove that Vishay really is No.1 for all your precision resistor needs.

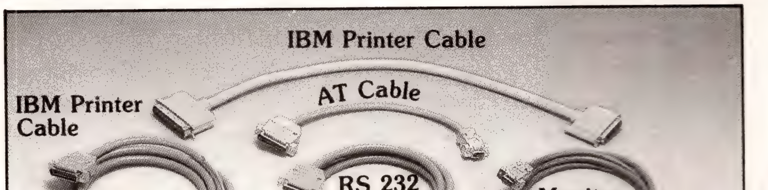
VISHAY ...to be precise®

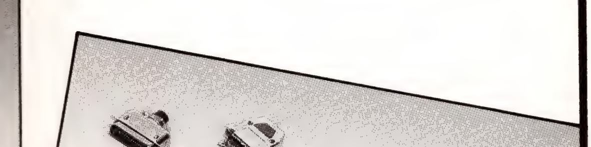
Vishay Mann Limited, Wymondham, Norfolk, NR18 0RA.
Tel: (0953) 606846. Telex: 975105 VISMAN G.
Vishay Micro-Mesures, 98 Boulevard Gabriel Peri,
92242 Malakoff cedex, P.O. Box 51 France.
Tel: (01) 46559800. Telex: 270140 VISHFRA.
Dale Electronics GmbH
Benzstr. 28, 8039 Puchheim, West Germany
Tel: (089) 80960. Telex: 5212950 DAL D

CIRCLE NO 109

COMPUTER CONNECTORS & CABLE ASSEMBLIES

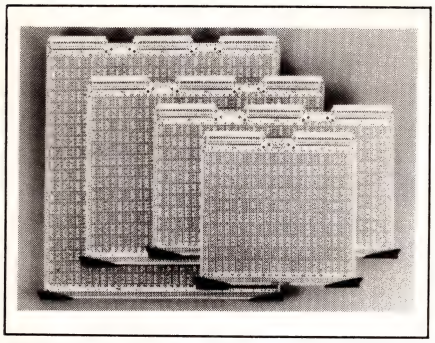
* Special designs and OEMs welcomed! * Overseas agents wanted!





Manufacturer & Exporter **NEW TAI KUNG ENTERPRISE CO., LTD.**
2nd. Fl., No. 147, Chengkung Rd., San Chung, Taipei Hsien, Taiwan, R.O.C.
Telex: 32434 TAI KUNG Fax: 886-2-9882243 Tel: (02)989-8819, 989-8804, 988-2242

CIRCLE NO 112

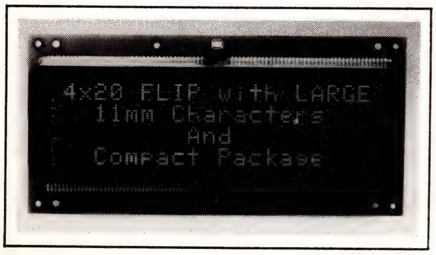


WIRE-WRAP BOARDS

The Series 207 Schottky-compatible wire-wrap boards are available with standard connector power commitments for VME Bus, Multibus II, or the company's Metric configurations. The board's construction and layout minimize system noise, crosstalk ringing, and propagation delay, and provide the fast rise and fall times associated with Schottky devices. All four boards feature 4-layer construction with copper interpinning around each pin on all layers. You can selectively commit any pin to the power and ground planes, and plated-through holes are spaced on 0.2-in. centers to equalize current flow and accommodate surface-mount decoupling capacitors. $625 to $1630.

Mupac Corp, 10 Mupac Dr, Brockton, MA 02401. Phone (617) 588-6110. Booth No 737.

Circle No 556

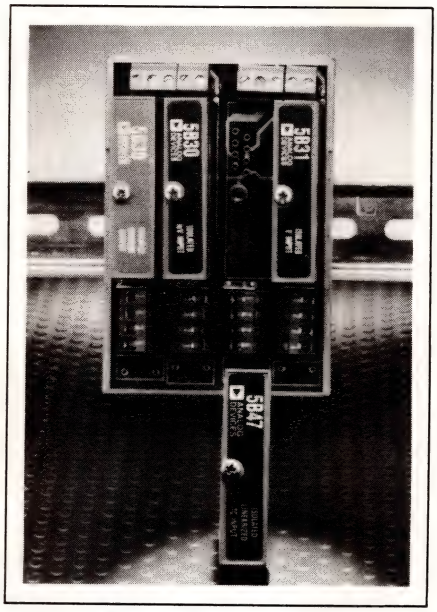


DISPLAY

The Model 3601-34-080 4-line×20-character vacuum-fluorescent display module has 11.3-mm-high characters that are formed from a 5×7 dot matrix and are readable from a distance of 10 ft. It operates from a 5V supply, and an onboard µP controls all display functions. A standard serial interface accepts either RS-232C or RS-422 data at 1200 or 9600 bps. The module displays the full 96-character ASCII font as well as additional European characters and scientific symbols. The blue-green display has a brightness level that specs at 160 fL and is dimmable to 80 fL via software control. $274 (100). Delivery, four to six weeks ARO.

IEE Inc, 7740 Lemona Ave, Van Nuys, CA 91409. Phone (818) 787-0311. TLX 4720556. Booth No 1453.

Circle No 551



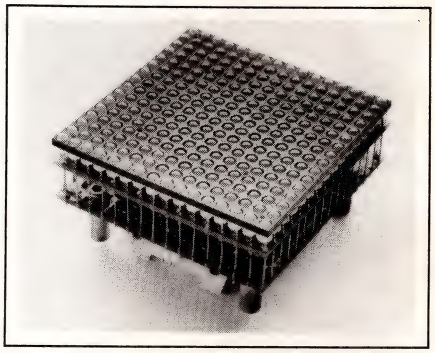
SIGNAL CONDITIONER

The 5B47 module accepts input signals from J-, K-, T-, E-, R-, S-, and B-type thermocouples and provides a linearized and isolated 0 to 5V output. It has a selectable signal-span range of ±5 mV to ±0.5V and processes J- and T-type thermocouple signals with ±0.5°C accuracy (combined nonlinearity, hysteresis, and repeatability). The zero and span accuracy equals ±0.05% of span. The normal mode rejection specs at 60 dB.

The module has a 240V-rms input-protection rating, 160-dB CMR, and a 1500V rms input-to-output common-mode voltage rating. The device includes cold-junction compensation circuitry that corrects errors caused by parasitic thermocouples formed by wire connections and screw terminals. Other features include open-thermocouple detection and a −25 to +85°C operating temperature range. $130 (250).

Analog Devices, Literature Center, 70 Shawmut Rd, Canton, MA 02121. Phone (800) 245-3900; in MA, (617) 461-3643. Booth No 1035.

Circle No 554



LED MODULE

Composed of 256 T1-type LED lamps arranged in a 16×16 matrix, the TLMM502A1 display module is available in red, green, and amber. It can replace CRTs in large-scale information-board applications—for example, airport and advertisement signs. The display module uses digital RGB driving circuits to provide compatibility with CRTs. As a result, it provides simple interface requirements in either graphic or alphanumeric display applications. It also has a Bright terminal that lets you adjust display brightness over a 1/16 to 15/16 range—a total of 16 gradient levels. $150 (100). Delivery, 10 to 12 weeks ARO.

Toshiba America Inc, Semiconductor Products Div, 2692 Dow Ave, Tustin, CA 92680. Phone (714) 832-6300. Booth No 2034.

Circle No 555

DC/DC CONVERTERS

The QWS Series 30W single-output dc/dc converters employ current-mode control technology and have no minimum output loading requirements. Internal control loops provide tight regulation for all outputs.

Text continued on pg 156

The ICE pacesetter that drives 15X faster than existing systems.

Rev-up your emulation performance. Do it faster and better than ever before. The SA98 from Sophia combines the flexibility to go from 8- to 32-bit microprocessors, and is fully compatible with IBM's PC/AT or XT. The SA98 is setting the pace as the price/performance leader.

Parallel Interface
Get a real speed boost over traditional RS-232 type interface with Sophia's unique parallel interface. You'll gain an 8X improvement in down load time. Optimize portability between IBM PC/AT, XT, or compatibles with Sophia's MS-DOS software drivers.

Unmatched Performance
Sophia's proprietary Direct Access Controller doesn't sidetrack ICE performance. It cuts through the curves others have to follow. The SA98, at high-speed, down loads to the target memory. Makes memory and data I/O modifications during program execution. Has full symbolic debugging. And you can view and augment trigger and trace conditions on-the-fly.

Dual Processor Emulation
Used in tandem, two SA98's emulate two separate 8- or 16-bit microprocessors simultaneously on a single host. Set your independent debug triggers, and emulation. The split screen feature displays code execution for each . . . independently.

Get Your Hands on the SA98
Experience the SA98 in action. Drive away with the real performance leader. You've got to see it to believe it.

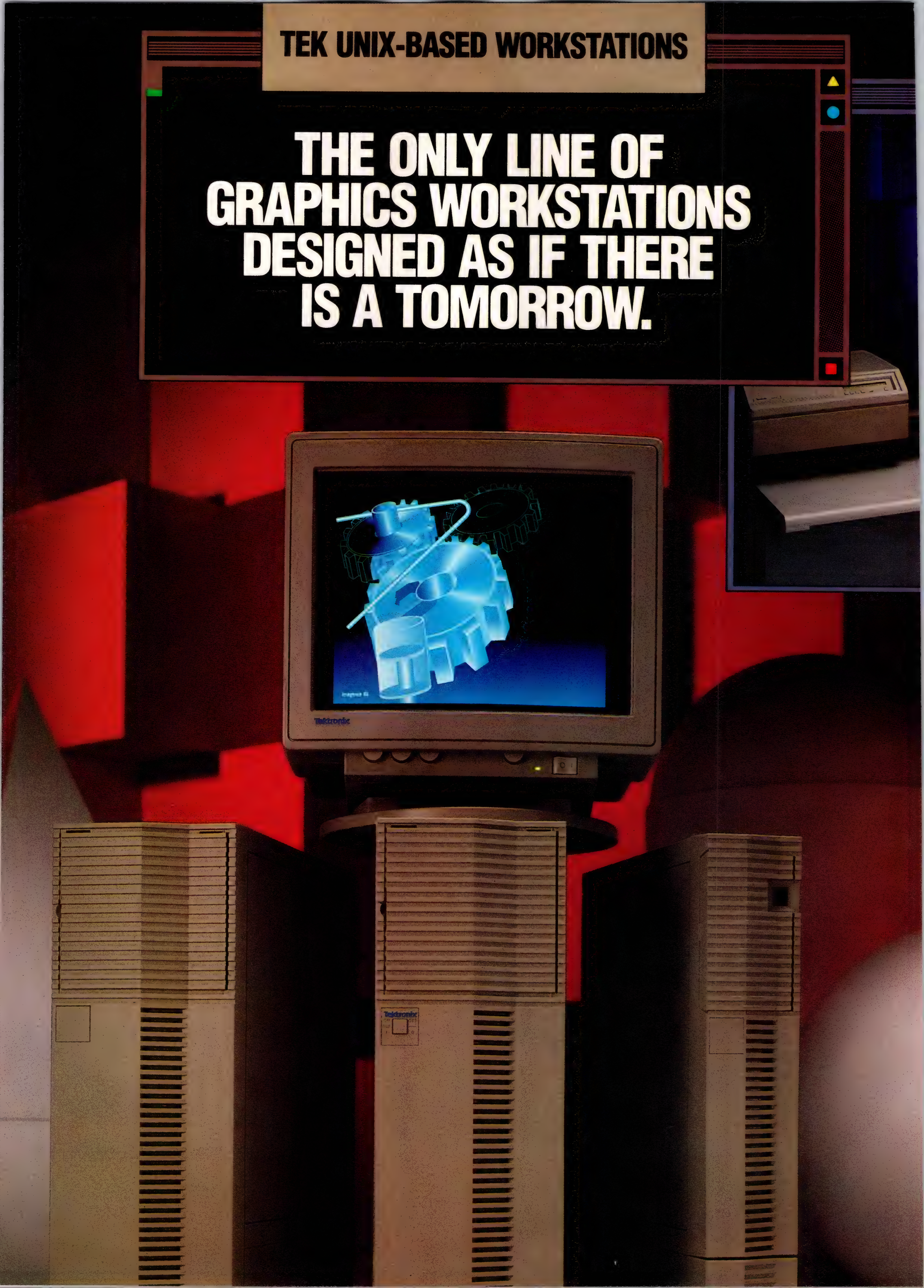
Call Toll-Free Today
1-800-824-9294 (U.S.)
1-800-824-6706 (CA)

Sophia systems

Dedicated to MDS/ICE Support

U.S. & European Headquarters: Sophia Systems, 3337 Kifer Road, Santa Clara, CA 95051 (408) 733-1571
Corporate Headquarters: Sophia Systems Co., Ltd., NS Bldg. 8F, 2-4-1 Nishishinjuku, Shinjuku-ku, Tokyo 160 03-348-7000
©1988 Sophia Systems. Sophia Systems is a registered trademark of Sophia Systems Co., Ltd.
ICE is a registered trademark of Intel Corporation. MDS is a registered trademark of Mohawk Data Science Corporation.
IBM PC/AT and XT are registered trademarks of International Business Machines Corporation.

CIRCLE NO 183


TEK UNIX-BASED WORKSTATIONS
THE ONLY LINE OF GRAPHICS WORKSTATIONS DESIGNED AS IF THERE IS A TOMORROW.
Tektronix

Finally there are graphics workstations as committed to incorporating industry standards and to ensuring upgradability, as to breaking today's graphics throughput barriers. You know that barriers are made to be broken. But that your investment in hardware and software, in systems and training, is made to last.

That's why Tek's new 4300 Series Workstations are designed with parallel graphics and compute processors. This architecture gives you the choice of putting Tek graphics to work in a workstation or terminal configuration. And because you can later upgrade that terminal to a fully integrated workstation, you know your investment in Tektronix engineering has lasting value.

Just as forward-looking is the fact that the 4300 Series includes the industry's most established standards: UNIX, 68020 processors, Ethernet, TCP/IP, X Windows, and Tek PLOT 10® software, enhanced to complement the high throughput of these new systems.

With 14 different configurations, a common user interface, Tek's de facto graphics standard, and unsurpassed quality, the 4300 Series allows not just leading performance until the next breakthrough comes along—but growth for tomorrow.

For more information on the 4300 Series, contact your local Tek representative today.
Or call 1-800-225-5434.
In Oregon, 1-235-7202.

CIRCLE NO 184

Copyright ©1987, Tektronix, Inc. All rights reserved. AHT-107
Graphics courtesy of: Imagence/Paris using DALIM,
PLOT 10® TekniCAD, ESRI, SDRC/CAE, and MCS.

Tektronix
COMMITTED TO EXCELLENCE

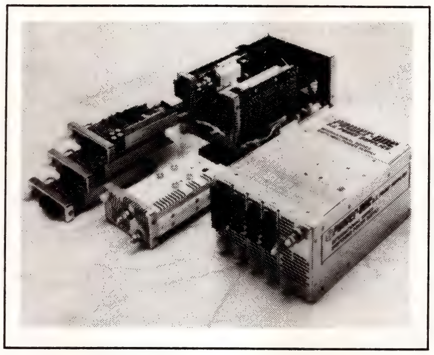
All modules operate at 100 kHz. Models are available that operate on nominal input levels of 24 and 48V dc, having 9 to 36V and 20 to 72V limits, respectively. All units output either 5, 12, or 15V. The full-load efficiency specs at 82 to 86% and is virtually unaffected by line and load changes. The output accuracy specs at ±1%.

The converter noise and ripple measures 75 mV p-p over a 20-MHz bandwidth. The transient response is less than 200 μsec with a 50% load change, and the temperature coefficient equals ±0.02%/°C. Load and line regulations spec at 0.5%. The converters are housed in encapsulated, all-metal cases to minimize radiation problems. $139. Delivery, stock to six weeks ARO.

International Power Devices Inc, 155 N Beacon St, Brighton, MA 02135. Phone (617) 782-3331. TLX 989752. Booth No 2724.

Circle No 546

POWER SUPPLY

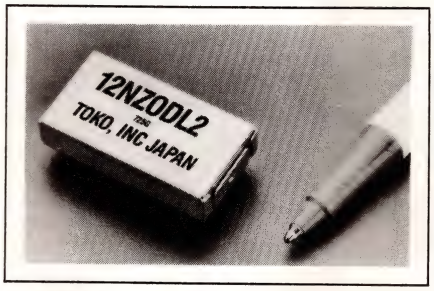


The Model SPM5 switch-mode power supply provides as much as 1500W of output power from as many as 15 outputs. It's based on a modular-design concept that allows you to specify a tailored multiple-output power system from a wide variety of off-the-shelf single-, dual-, and triple-output plug-in power modules. All outputs are independent and floating, and can be configured for either positive or negative output levels. The outputs use fully isolated MOSFET switching regulators to achieve high conversion efficiency in a small package—the power density measures 3.4W/in^3.

Current-mode control techniques help achieve precise current sharing when you operate outputs in parallel. The supply features field-selectable ac inputs that are compatible with worldwide requirements—90 to 132/180 to 264V, 47 to 440 Hz. The units meet VDE, IEC, CSA, and UL safety standards, and FCC and VDE EMI limits. $924 (250).

Power-One DC Power Supplies, 740 Calle Plano, Camarillo, CA 93010. Phone (800) 235-5943; in CA, (800) 421-3439. Booth Nos 464 and 466.

Circle No 548

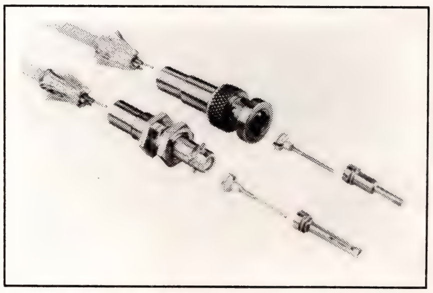


DC/DC CONVERTERS

The DL Series dc/dc converters use a thick-film circuit design to pack a 2W output capability into a 7.3×30×16-mm package. In addition, they feature a ceramic substrate that dissipates heat very rapidly. Three models are available in the series; all operate on 12V inputs and output either −5, −12, or −15V. The switching frequency ranges from 100 kHz to 140 kHz, depending on the model. The −12 and −15V models operate at 65% efficiency and the −5V unit has a 55% efficiency. Built-in choke coils and a well-shielded case virtually eliminate EMI/RFI problems. The case features grounding tabs and pc-type terminations that simplify installation. From $36.50.

Toko America Inc, 1250 Feehanville Dr, Mt Prospect, IL 60056. Phone (312) 297-0070. TLX 724372. Booth No 1526.

Circle No 557

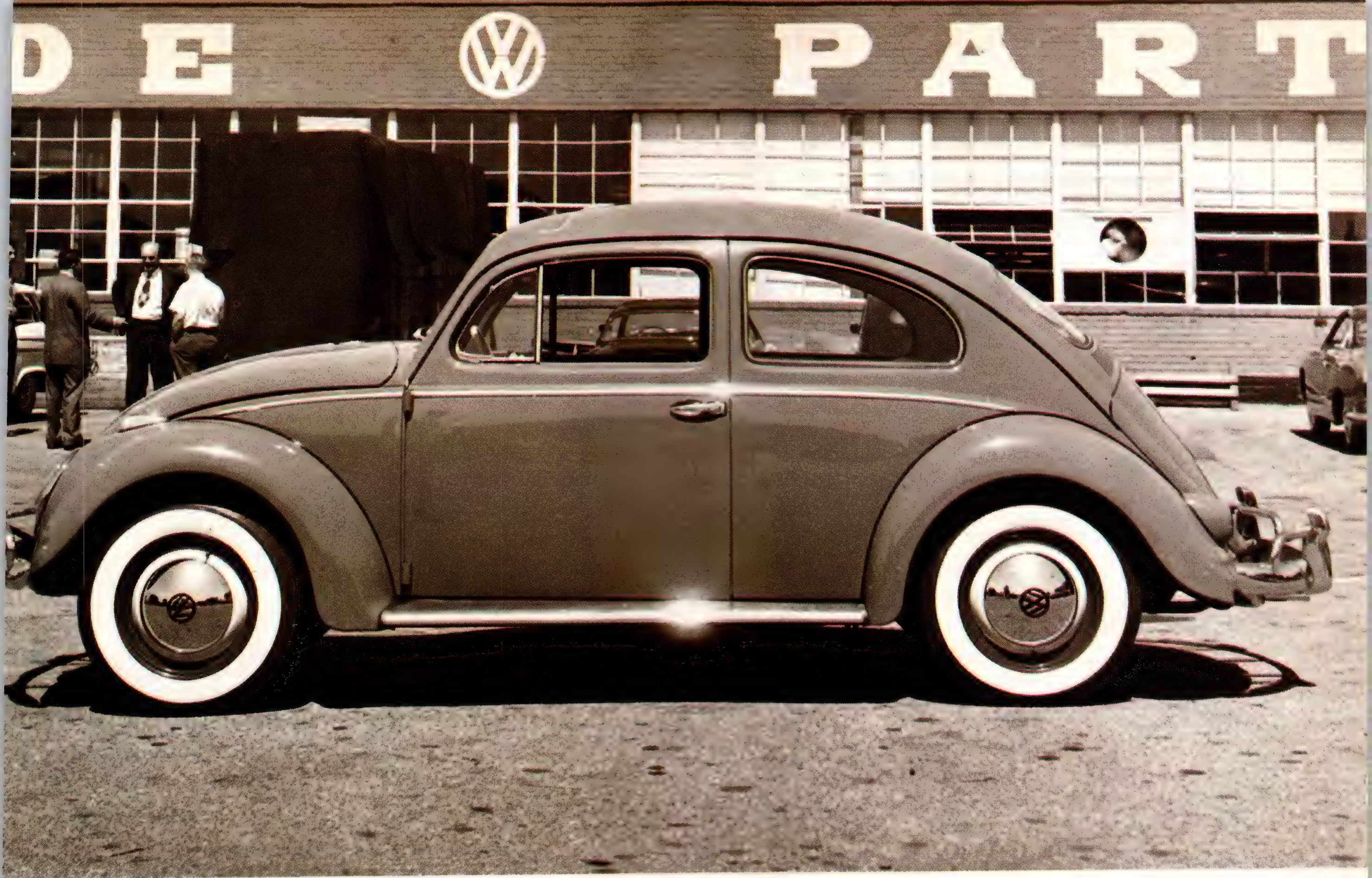


CONNECTORS

The field-installable, solderless, concentric twinax connectors in the 450 Series are designed for MIL-STD-1553B and MIL-STD-1760 digital data-bus applications. The series includes cable plugs and jacks, bulkhead cable jacks, and right-angle plugs. The connectors' plating satisfies the 500-hour salt-spray requirements of MIL-STD-1344A. Sealing gaskets and heat-shrink tubing provide weatherproofing. Center and intermediate contacts are interchangeable between pin or socket configurations; this interchangeability improves polarization capabilities and minimizes inventory requirements. The keying options include threaded types as well as 3- and 4-lug bayonet versions in multiple-lug positions. $15 to $20 (1000).

Trompeter Electronics Inc, Box 5069, Westlake Village, CA 91359. Phone (818) 707-2020. TWX 910-494-1210. Booth No 374.

Circle No 552



The Bettman Archive Inc.

Making something very small can be truly revolutionary.

At first people scoffed. Some laughed out loud. But the people's car set a new size standard for an entire industry.

Sizes are still shrinking in the micro-miniature world of cable and connector technology at Precision Interconnect. We're designing the critical link between man and machine. These complete interconnect systems, usually using 38 AWG conductors, can be terminated to standard connectors with flex-strain reliefs or contain active devices within custom-molded housings.

To make these cable systems increasingly smaller, lighter, more rugged, and more comfortable to use without compromising signal fidelity, flex-life, or reliability is a continuing challenge presented to us by manufacturers of leading-edge medical equipment around the world.

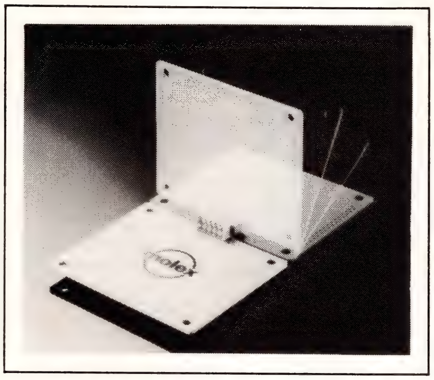
Our expertise, increasing with each unique problem we solve, ensures that reliability is designed in, built in, and tested. So we can solve big problems. With small, but revolutionary, innovations.

PRECISION
INTERCONNECT

16640 S.W. 72nd Avenue, Portland, OR 97224
(503) 620-9400
Offices in San Francisco, Boston,
Wilmington and Düsseldorf

Neonatal sensor for SensorMedics oximeter measures pulse and blood gases.

CIRCLE NO 194



PC-BOARD CONNECTORS

These 2-piece hinged connectors feature a 1.25-mm contact centerline spacing. Measuring only 10.3×6.7 mm, the connectors are available in even-numbered sizes ranging from 4 to 20 positions. The connector design makes it easy to access the pc-board surface. The connectors mate on the co-planar axis or board-edge to board-edge, and allow you to rotate the boards by as much as 90°. They also mate in the reverse position when the pc boards are lined up in parallel position.

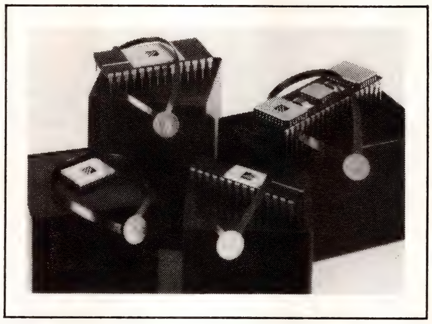
The connectors utilize a high-pressure, tuning-fork-type contact system. The terminals are tin-plated phospher bronze. To facilitate soldering operations and board-mounting stability, solder tails are arranged in a staggered pattern. The mating and rotation lifetime spec at 30 and 50 cycles, respectively. The connector housings are molded of UL 94-V0-rated polyester. The connectors have per-circuit contact ratings of 125V at 1A. $0.054/circuit. Delivery, seven to eight weeks ARO.

Molex Inc, 2222 Wellington Ct, Lisle, IL 60532. Phone (312) 969-4550. TLX 254069. Booth No 1708.

Circle No 549

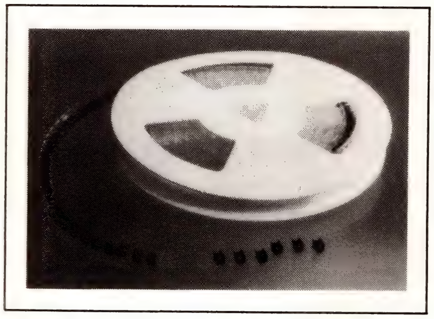
STATIC RAMs

The 256k×1-bit EDI81256C and the 64k×4-bit EDI8464C static RAMs offer access times of 34, 45, and 55 nsec. The EDI8832C, organized as 32k×8-bits, provides access times of 45 and 55 nsec. The ×1 and ×4 devices are available in a 24-pin, 300-mil DIP or a 28-pin LCC; the ×8 device is available in a 28-pin, 600-mil DIP or a 32-pin LCC. All of the devices conform to JEDEC standard pinouts and meet the requirements of MIL-STD-883C. The EDI8M1664C is a high-speed 64k×16-bit module, containing four 32k×P8-bit devices in leadless chip carriers surface-mounted on a ceramic substrate on a 40-pin, 600-mil DIP. EDI81256C and EDI8464C, $302 to $453; EDI8832C, $223; EDI8M1664A, commercial version, $249 to $445; military version, $496 to $860 (100).



Electronic Designs Inc, 42 South St, Hopkinton, MA 01748. Phone (617) 435-2341. TLX 948004. Booth Nos 2827 and 2829.

Circle No 561

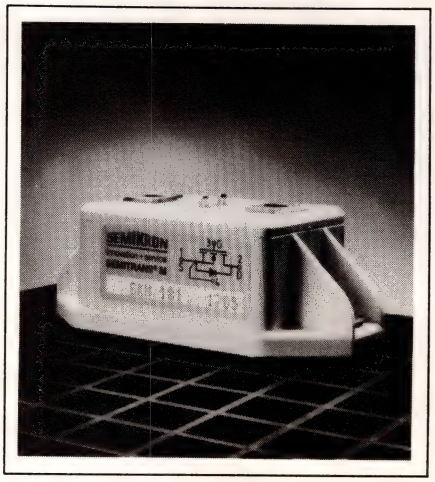


SURFACE-MOUNT LED

The configuration of the 6200 Series right-angle, surface-mount LED provides easy visibility, making the device particularly suitable for high-density applications where boards are mounted in parallel. The device is available in red, green, and yellow. The 12 models include standard and low-current versions as well as standard and low-current versions that include a resistor and operate from 5V. The series' design and packaging meet the requirements of automated surface-mount production-line equipment. The device can withstand the processing temperatures of either IR or vapor-phase reflow soldering operations. It's available on 16-mm tapes that hold 1000 LEDs/reel. $0.89 (1000).

Industrial Devices Inc, 260 Railroad Ave, Hackensack, NJ 07601. Phone (201) 489-8989. Booth No 2143.

Circle No 550



POWER MODULES

The SKM-181 rated at 30A, 800V and the SKM-151F rated at 50A, 500V each contain several power MOSFETs connected in series and in parallel in an isolated package. The SKM-151F also includes an integrated fast-recovery diode. The package has an isolation voltage rating of 2500V. The short internal connections minimize lead inductance and the possibility of parasitic oscillations. The modules also eliminate the labor-intensive job of paralleling TO-3 or TO-220 devices. A single module can replace as many as six individual TO-3 power MOSFETs. Because of the top-mounted connections, it is easy to connect the modules to bus bars. SKM-151F $70 (50).

Semikron Inc, Box 66, Hudson, NH 03051. Phone (800) 258-1308; in NH, (603) 883-8102. Booth No 818.

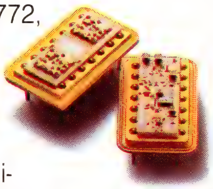
Circle No 558

IF YOU'RE NOT CONSIDERING OUR OP AMPS, YOU'RE NOT GETTING THE WHOLE PICTURE.

Teledyne Philbrick op amps. The front-runners for speed and accuracy. Fast settling over a wide bandwidth is the essence of high-performance op amps in sophisticated, high-speed data acquisition, microwave transmission and video/CRT applications. So it pays to specify the best: the 1467 and 1493 operational amplifiers from Teledyne Philbrick.

These Teledyne Philbrick designs are specially engineered to maximize DC characteristics and high-speed performance. The 1467, 1GHz gain-bandwidth op amp ensures 70ns settling times to ±0.01%FS while providing ultra-low input offset voltage of ±30μV and input offset voltage drift of ±1μV/°C.

The 1493, a dual 350MHz gain-bandwidth op amp, features individual compensation and offset adjustments, FET inputs, 180ns settling times to ±0.01%FS and 80dB isolation at 100KHz.



Qualified to MIL-STD-1772, Teledyne Philbrick is a leading manufacturer of high-performance, high-reliability standard and custom microcircuits for industrial, medical, military and space applications worldwide. Send for complete specifications or call us toll-free at 1-800-325-1330 (outside MA).

MIL-STD-1772 Qualified

TELEDYNE PHILBRICK

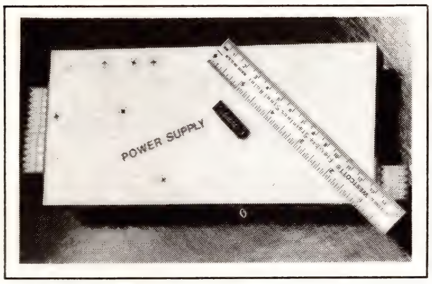
40 Allied Drive, Dedham, MA 02026-9103, Tel: 617-329-1600 Fax: 617-326-6313

WEST:
30423 Canwood St.,
Suite 212
Agoura Hills
CA 91301
Tel: (818) 889-3827
Fax: 818-889-8215

U.K.:
The Harlequin Centre
Southall Lane
Southall
Middlesex
UB2, 5NH, U.K.
Tel: 571-9596
Telex: 935008
Fax: 571-9442

JAPAN:
4th Floor
Taiko No. 3 Bldg.
2-10-7 Shibuya-Ku
Tokyo 542, Japan
Tel: 797-5251
Telex: 781-24335
Fax: 797 5255

CIRCLE NO 186

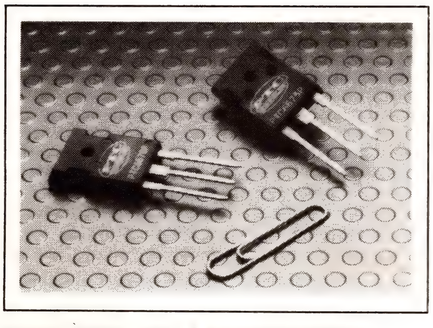


SMPS CONTROLLER

Designed for resonant-mode switching power supplies, the LD405 uses frequency modulation to control the regulation. The pulse width is held constant while the frequency is varied in response to load changes. Operating at high frequencies in the resonant mode, the device provides several advantages over conventional modes of operation. These advantages include reduced power-supply size and weight, reduced switching losses, and reduced component stress caused by zero-current switching. Other features include overload shutdown, soft start, and the ability to drive power MOSFETs directly. 16-pin plastic DIP, $3.50 (1000).

Gennum Corp, Box 489, Station A, Burlington, Ontario, Canada L7R 3Y3. Phone (416) 632-2996. TLX 0612996. Booth Nos 389 and 391.

Circle No 560

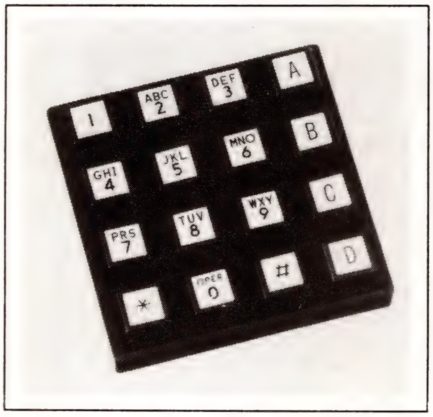


POWER TRANSISTORS

The PTC6675P and PTC6678P npn power transistors, available in TO-247 plastic packages, are electrically equivalent to the 2N6675 and 2N6678 devices in TO-3 metal cans. The TO-247 devices can replace TO-3 types in nonhermetic environments. The PTC6675P is rated at 10A, and the PTC6678P is rated at 15A. Both devices have sustaining-voltage ratings of 400V. The switching characteristics include a storage time of 2.5 μsec and a fall time of 0.5μsec. PTC6675P $3.45, PTC6678P $4.75 (100).

Power Technology Components, 23201 S Normandie Ave, Torrance, CA 90501. Phone (213) 534-3737. TLX 664276. Booth No 2934.

Circle No 559

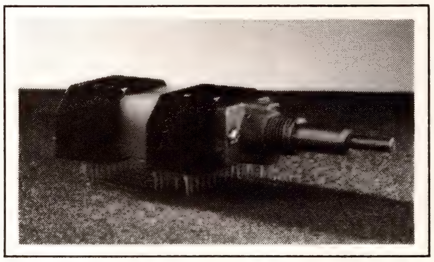


16-BUTTON KEYPAD

Encapsulated in a military grade, silicone rubber boot, the Series 84 4×4-button keypad is sealed from its environment when mounted on a panel. A snap-dome contact system provides tactile feedback, and the contact side of the dome is gold plated to ensure low contact resistance for 3M operations/button. Each button switch is rated at 24V dc/10 mA. The device also features EMI shielding and custom button legends. $25.85 (100). Delivery, six to eight weeks ARO.

Grayhill Inc, 561 Hillsgrove Ave, Box 10373, LaGrange, IL 60525. Phone (312) 354-1040. Booth No 1301.

Circle No 566



ROTARY SWITCH

You can use the S-400 rotary switch, which comes in 8- and 12-pin versions, in applications that require multifunction switching in a minimum amount of space. The switch construction provides for the sealing in of the lifetime lubricant and allows a mechanical life of 25,000 operations. Detent angles of 30, 60, and 90° are available, as are a variety of shaft and bushing sizes. Special options include molded Delrin spacers between decks and shaft extensions. The switch can carry 6A and has a make/break rating of 0.1A at 125V ac and 0.25A at 28V dc. $8 (OEM qty).

Electroswitch, 2510 North Blvd, Raleigh, NC 27604. Phone (919) 833-0707. Booth No 2858.

Circle No 565

CLOCK OSCILLATOR

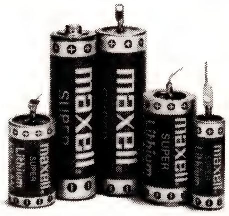
This clock oscillator provides dual outputs, using independently operating crystals. It uses high-speed CMOS technology and is TTL compatible. Frequencies from 4 MHz to 60 MHz are available. The module not only saves board space, but costs less than two individual clocks. For frequencies in the 4-MHz to 18-MHz range, the module costs $2.90 (25,000). Evaluation samples are available.

Pletronics Inc, 9026 Roosevelt Way NE, Seattle WA 98115. Phone (206) 523-9395. TLX 4740170. Booth No 2119.

Circle No 562

POWER PLUS SAFETY.

The Maxell Super Lithium Battery.* Good for a decade, these lithium thionyl chloride batteries are hermetically sealed for super safety plus long shelf and service life. And at 3.6 volts, they supply the high energy density you're looking for.



Specify Maxell Super Lithium Batteries for critical applications where a safe battery is imperative.

Specify Maxell Super Lithium Batteries for quality and a name you can trust. When you need power and you need it safe, look for Maxell.

maxell.

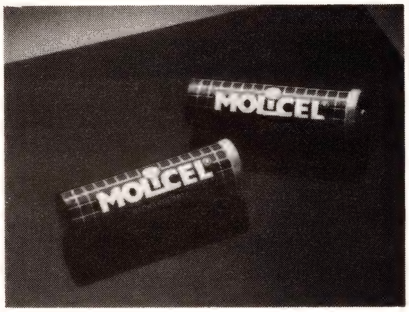
Maxell Corp. of America
22-08 Route 208
Fair Lawn, NJ 07410

*Recognized under the Component Program of Underwriters Laboratories.

See us at ELECTRO, Booth 3013

CIRCLE NO 185

Electro/88 Products

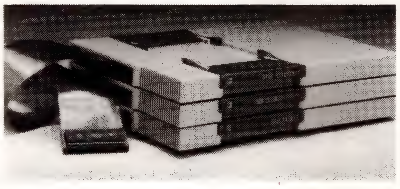


LITHIUM CELLS

The Molicel rechargeable lithium cell comes in an AA-sized package and can operate from 1.3 to 2.4V. You can choose various voltage limits, depending on the discharge rate, operating temperature, and capacity and life-cycle requirements. The cell features an 0.6 Ahr capacity and, after one year at room temperature, provides 90% charge retention. The unit operates from −30 to +55°C and, when subjected to a discharge current of 120 mA, reaches a 1.3V cut-off voltage in 300 minutes. The unit weighs 22g. $3 (10,000).

Moli Energy LTD, 3958 Myrtle St, Burnaby, British Columbia, Canada V5C 4G2. Phone (604) 437-6927. TLX 04356708. Booth No 2228.

Circle No 545



EMULATOR

The EL 800 in-circuit emulator performs zero-wait state emulation of the Z-80H μP at 8 MHz and of the HD64180 at 6 MHz and does so without preempting any interrupts. To minimize propagation delays, the emulator uses a hybrid circuit that plugs into the target μP socket and drives the 16-in. cable back to the emulator. The vendor provides the emulator in the form of 8.5×11×0.85-in. modules that stack on top of each other and snap together to make electrical as well as mechanical connections. You need only purchase one module; you add additional features by adding modules. A single power supply drives all the units. Your personal computer must run MS-DOS version 3x and have 640k bytes of RAM. $4850.

Applied Microsystems Corp, Box 97002, Redmond, WA 98073. Phone (206) 882-2000. TLX 185196. Booth Nos 804, 806, and 808.

Circle No 567

SIMULATOR

The handheld NSG 432 electrostatic discharge simulator tests electronic equipment for susceptibility to electrostatic discharges as defined in 16 current and proposed national and

Text continued on pg 167

With a Stag PP38 You Don't Have to Blow Your Budget to Burn Your PROMs

$1250

Compare the **NEW Stag PP38** to any EPROM/EEPROM programmer in its class and it will out perform them all.

Features such as a comprehensive device library, manufacturers' approved programming algorithms, Stag's high quality of manufacture and low price, backed by Worldwide support make the PP38 the ideal choice.

It can program two identical devices simultaneously and handle 8, 16 and 32-bit sets. In fact the PP38 can program a 16-bit set in just one operation.

We've even included an RS232C interface so you can remotely control the PP38 from your PC and 11 formats are provided for interfacing to development systems.

Comprehensive editing features such as Insert, Delete, Block Move and String Search are included for total data control.

You can rely on us to burn your EPROMs and not blow your budget.

Contact your nearest regional office for more details and a FREE TRIAL of the best programmer at $1250.

Stag Microsystems Inc,
1600 Wyatt Drive,
Santa Clara, CA 95054,
Tel: (408) 988-1118

Stag Microsystems Inc,
3 Northern Boulevard,
Amherst, NH 03031,
Tel: (603) 673-4380

stag

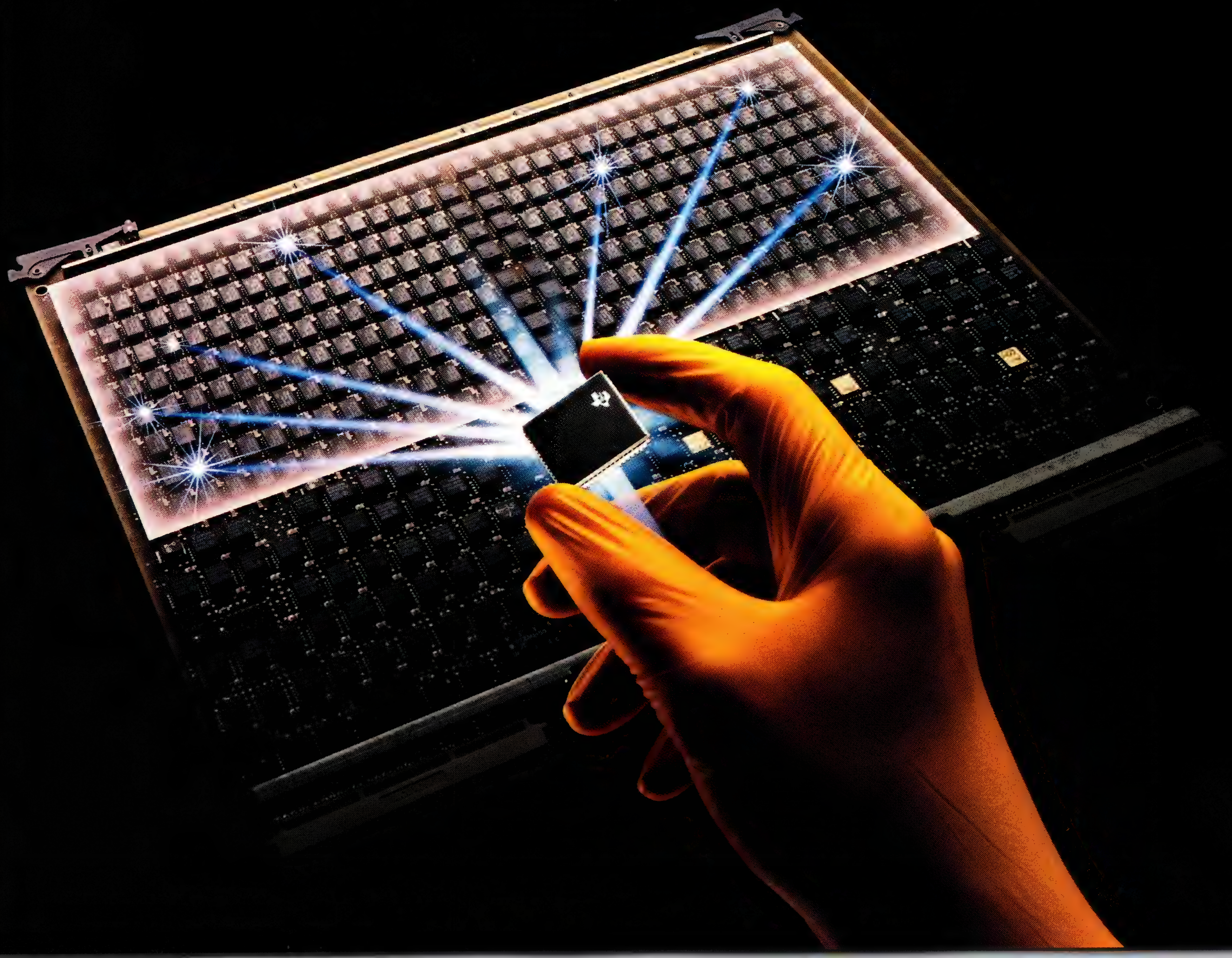
Sophisticated systems for the discerning engineer

TEXAS INSTRUMENTS REPORTS ON

MEMORY MANAGEMENT

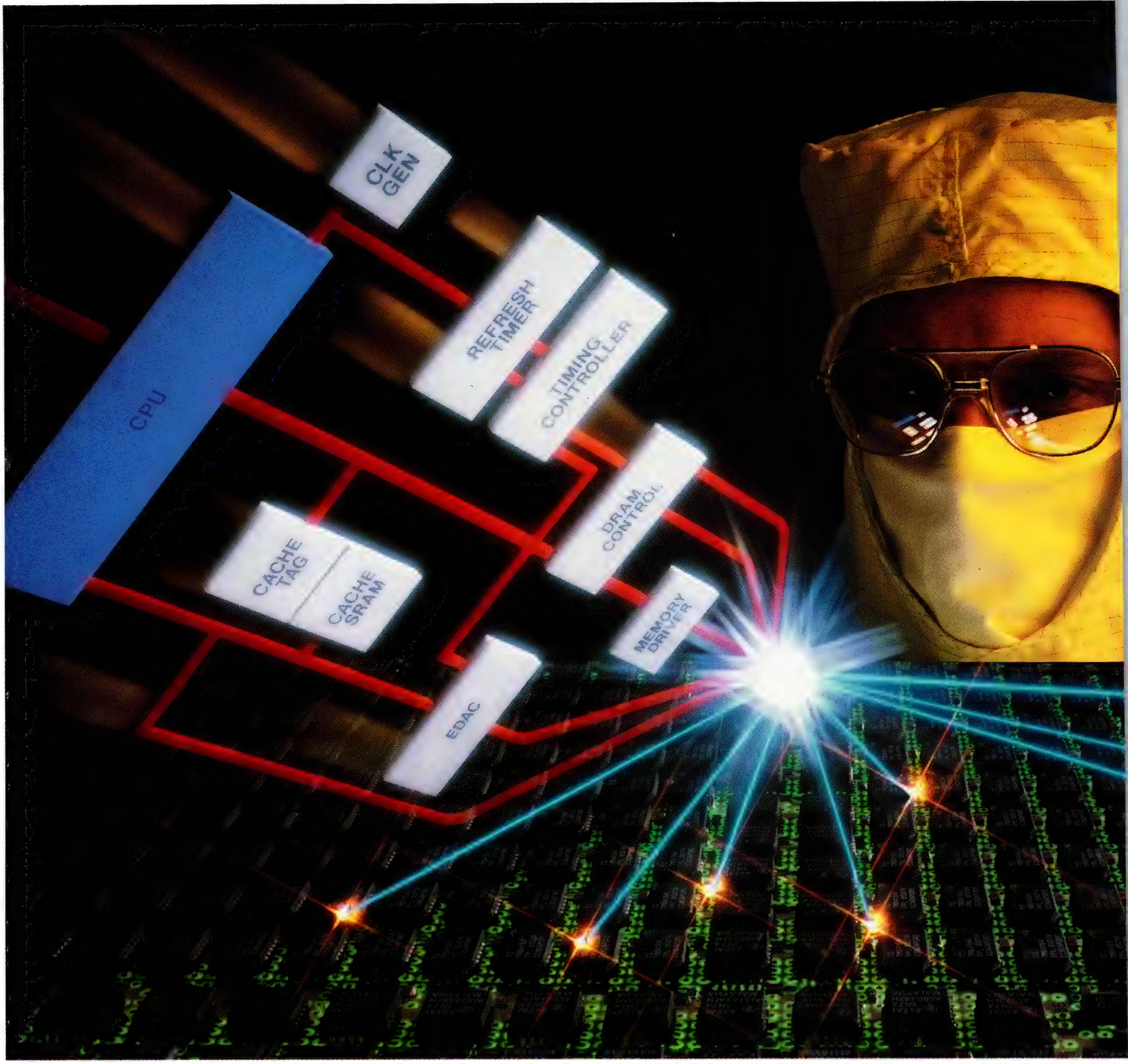
IN THE ERA OF

MegaChip TECHNOLOGIES



Memory management in the Era of MegaChip Technologies:

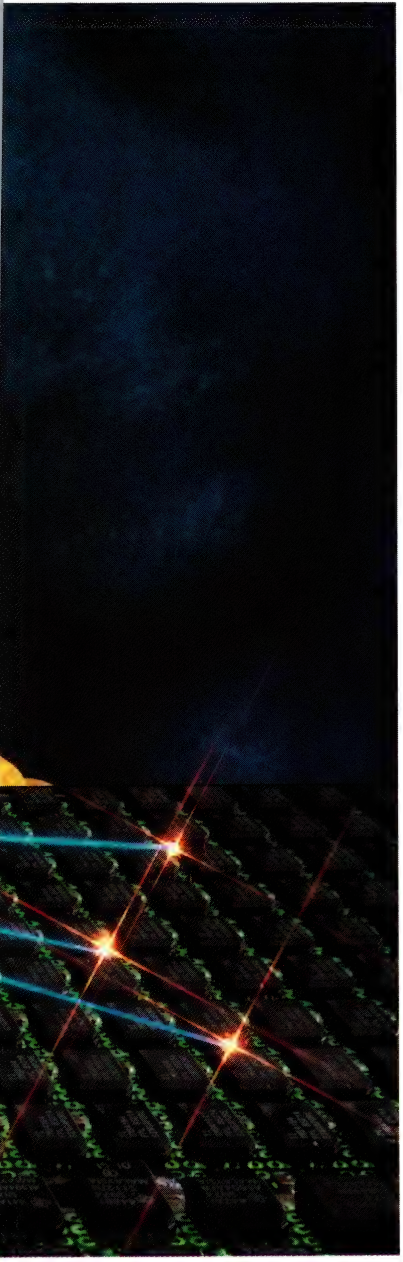
Memory-management ICs fron you bring memory arrays up tc



Memory systems are a prime area for significant improvements in overall system throughput. Read how TI's memory-management ICs can get you in and out of memory faster no matter which processor you choose.

You can now solve a problem whose solution has eluded design eng neers for years: How to catch memor speeds up to CPU speeds. The solutic lies with TI's advanced memory-management circuits, and you can us them with whichever processor best suits your application.

exas Instruments can help rocessor speeds.



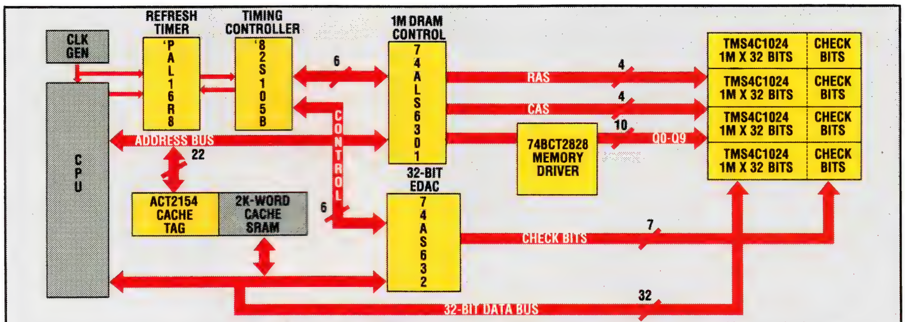
A universal architecture enables
ese TI devices to work with — and
hance — virtually any high-speed
icroprocessor or bus structure, even
istom engines.

In addition, your component count
cut because these are single-chip
LSI circuits. Your design time and
fort are shorter and easier because of TI's comprehensive Memory Management Design Kit *(see page 4)*.

TI addresses your major memory-design concerns

To immediately improve memory-access time, use both main and cache memories, as shown in the block diagram. This approach can produce up to a 3X increase in system performance.

Frequently accessed data and instructions are stored in a few high-speed static random-access memories and "tagged" by a TI industry-standard cache controller (SN74ACT2151/4). These 2K×8 CMOS controllers are the fastest available and can support deep cache architectures of 16K or even 32K.



High-speed memories can be designed with less effort and implemented more cost-effectively by using TI's family of universal memory-management ICs. These devices, all of which are contained in TI's Memory Management Design Kit, will work with and enhance almost any high-speed processor.

This scheme is cost-effective because slower, less expensive dynamic random-access memories (DRAMs) can be used for main memory.

When you must assure system integrity, use of an error-detection-and-correction (EDAC) circuit can improve system reliability 500-fold. Since this approach is necessary with memory arrays larger than half a million bits, TI offers its leadership 32-bit EDAC.

The SN74AS632 detects dual-bit errors and detects and corrects single-bit errors while avoiding processor wait states. And at 25 ns for error detection, it meets your high-performance needs.

Interfacing between processor and main memory gets tougher as speeds increase. But TI has the SN74ALS6301 DRAM timing controller. It can handle any DRAM up to 1 Mbit and incorporates only the essential functions on chip to improve flexibility and speed and to allow for custom timing routines. This controller supports nibble- and page-mode access and scrubbing-mode refresh to increase memory output.

TI's MegaChip Technologies

Our emphasis on volume manufacturing of high-density circuits is the catalyst for ongoing advances in how we design, process, and manufacture semiconductors and in how we serve our customers. These are our MegaChip™ Technologies. They are the means by which we can help you and your company get to market faster with better, more competitive products.

Soon to come: An ASIC (application-specific integrated circuit) solution.

Reducing over/undershoot is accomplished by TI's 2000 Series buffers and drivers — 25-ohm series-damping resistors on the output prevent false reads at DRAM input. For example, the SN74BCT2828 driver can reduce undershoot by 40% compared to traditional approaches. TI's 2000 Series has a high-drive current suitable for VME and MULTIBUS® II bus structures.

You can use any or all of TI's memory-management ICs to obtain the superior performance that marks a market winner. And there's no design rule that says your memory-management chips and your CPU have to come from the same supplier.

▶ *Turn page for more information.*

The tools you need to design a high-performance memory-management system are between these covers:

At $149, the value of TI's Design Kit far outweighs its cost. In one compact file, we've included just about everything you'll need to bring your memory array up to speed. Everything, that is, except your imagination in creating your own unique product differentiators. Here's what you get:

- All necessary high-performance ICs, including
  - —SN74ACT2154 2K×8 Cache Address Comparator
  - —SN74AS632 32-bit EDAC
  - —SN74ALS6301 16K to 1 Mbit DRAM Controller
  - —SN74BCT2828 10-bit Buffer/Driver with series-damping resistor
  - —TIBPAL16R8-10 and TIB82S105B High-speed Programmable-logic Devices for user-defined timing control
  - —TMS4464 256K DRAM
- *Memory Management Applications Handbook* containing applications reports and briefs that supply valuable insights into memory-management system design.
- Data sheets on TI circuits designed for efficient memory management.
- Memory-management-product software graphic-symbol libraries and supporting documentation for use with Futurenet™ or Mentor Graphics™ CAE systems.

For more information on TI's Memory Management Design Kit, call 1-800-232-3200, ext. 3203, or contact your nearest TI field sales office or authorized distributor.

Texas Instruments Incorporated
P.O. Box 809066
Dallas, Texas 75380-9066

SDV063ED800C

YES, please send me more details on TI's universal memory-management ICs.

NAME

TITLE

COMPANY

ADDRESS

CITY STATE ZIP

AREA CODE TELEPHONE EXT.

™MegaChip is a trademark of Texas Instruments Incorporated.
Futurenet is a trademark of Futurenet Corporation.
Mentor Graphics is a trademark of Mentor Graphics Corporation.
®MULTIBUS is a registered trademark of Intel Corporation.

27-4510A

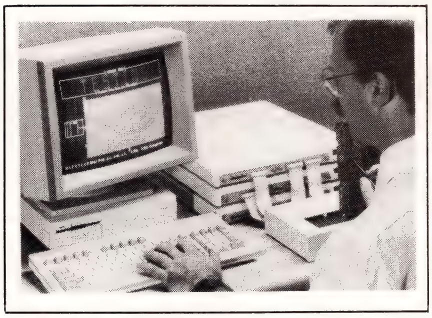
© 1988 TI

TEXAS INSTRUMENTS

international standards. The standard unit produces a positive-polarity output that you can set from 2 to 25 kV; you can obtain negative-polarity output by replacing a plug-in module. To use the gun-shaped unit, you select the voltage you want it to dispense, then touch the unit's tip to the part of the device under test where you want to simulate the effect of a static discharge. Pulling the standard unit's trigger prompts the discharge of a 150-pF capacitor through a 150Ω resistor to generate a narrow pulse. You can special order units that have different R and C values. The gun runs off a separate, high-voltage supply; you can obtain an optional power supply that lets you initiate discharges once per second. $4900 in PR.

Schaffner EMC Inc, 825 Lehigh Ave, Union, NJ 07083. Phone (201) 851-0644. TLX 6853444. Booth Nos 2717 and 2719.

Circle No 568



TEST SYSTEMS

MCP-2 software adds analog test-generation and analysis capabilities to systems containing as many as 15 of the vendor's MFI-1000 mainframes, including GFT-family component and populated-board testers. According to the vendor, the software eliminates most of the programming usually required to produce test programs and thus greatly reduces the time you must devote to their creation. The software's "learn" mode builds a tolerance database from a statistical sample of known-good units; the software uses this database to create analog- and digital-waveform guard bands. You can create test vectors with a waveform editor or you can transfer them from simulators. A macro control language, which links tests with conditional branching, eases component-level fault isolation. MCP-2, $695; test systems, from $5000.

ELMA

VMEbus EUROCARD

THE WORLD'S LARGEST LINE OF MODULAR SYSTEMS

The painstaking design effort you've invested in your computer system deserves the very **best** hardware. Elma offers no less in **complete** ready-to-work systems or building blocks. From precision card cages and enclosures to fans, power supplies, high performance backplanes, drive modules and connector plates; Elma gives you the world's largest easy-to-work-with modular component line. Fully compatible with world-wide Eurocard, VMEbus and Multibus II standards, most components are immediately available from stock.

POWER SUPPLIES
CARD CAGES
FAN MODULES
BACKPLANES (3 to 21 slot)
4-U RACK/DESK-TOP SYSTEM ENCLOSURE (Up to 7 boards)
KEYBOARD SYSTEM ENCLOSURE (Up to 7 boards)
25 JAHRE ANNÉE YEARS
ELMA Electronic

CALL OR WRITE FOR FULL FACTS:

ELMA

ELMA Electronic, Inc. • 41440 Christy St. • Fremont, CA 94538
PHONE: (415) 656-3400 • Fax (415) 656-3783

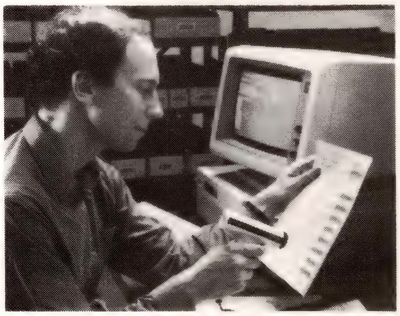
CIRCLE NO 9

Array Analysis, 200 Langmuir Lab, Brown Rd, Ithaca, NY 14850. Phone (800) 451-8514; in NY, (607) 257-6800. Booth No 2833.

Circle No 569

BAR-CODE SCANNER

S25 Series handheld, noncontact, bar-code scanners include units that feature internal decoding and a DB-25 connector that connects directly to a computer's RS-232C port. The scanners read 0.007-, 0.010-, and 0.020-in. bars. The units, enclosed in polycarbonate housings, employ visible-red light sources composed of four or six LEDs, depending on the bar size. You use a thumb-activated trigger to switch on the LEDs during scans; at other times, the LEDs remain in an off-state in order to conserve battery life. $310 to $575.



Skan-a-matic Corp, Box S, Elbridge, NY 13060. Phone (315) 689-3961. TWX 710-545-0220. Booth No 2125.

Circle No 570

Today's Advanced Technology Demands Batteries With A Future

Made in the United States of America

Innovative research and design enables Eagle-Picher to consistently provide highly reliable power sources for today's high-technology products.

The *Carefree*® and *Carefree*™ *Magnum* series represent the most flexible lines of maintenance-free, rechargeable, sealed, lead-calcium batteries in the world.

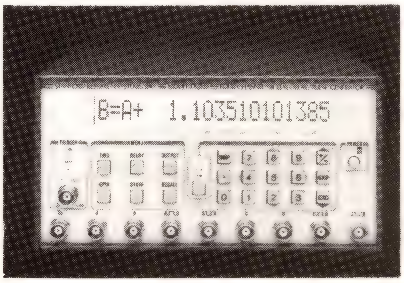
The electro chemistry of the *Keeper II*® *Lithium* series ensures up to 10 years of dependable service in standby applications where long-life memory back-up is required.

EAGLE EP PICHER

Eagle-Picher Industries, Inc.
Box 130 • Bethel Road • Seneca, MO 64865
Phone: (417) 776-2256 • TWX-62864271

Circle 187 for Keeper Battery

Circle 188 for Carefree Battery



PULSE GENERATOR

The DG535 pulse-and-delay generator outputs complementary pulses on two pairs of lines after effecting programmable, crystal-controlled delays. These delays can span 0 to nearly 1000 sec, and you can set them in 5-psec increments. The unit includes four independent delay generators. You can determine the width of an output pulse by programming either a start and a stop delay or a start delay and a pulse duration. You can choose among four output pulse levels—TTL (0 to 4V), ECL (−1.8 to −0.8V), NIM (−0.8 to 0V), and variable (offset, adjustable from −3 to 4V; amplitude, adjustable from 0 to 4V). The generator drives high-impedance or 50Ω loads with a 2-nsec transition time on the ECL output and with a 3-nsec transition time on the TTL output. The overshoot equals <100 mV+10% of the pulse amplitude. The unit, which is fully programmable via an IEEE-488 interface, will output pulses continuously from 0.001 Hz to 1 MHz. It can also output bursts of two to 32766 pulses. $2995.

Stanford Research Systems Inc, 1290D Reamwood Ave, Sunnyvale, CA 94089. Phone (408) 744-9040. TLX 706891. Booth No 2154.

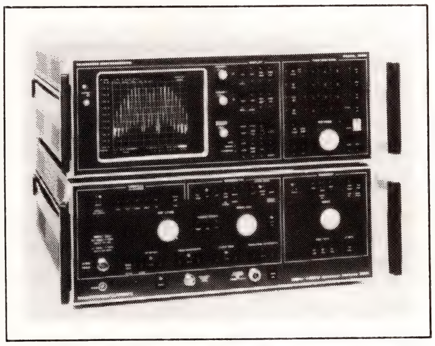
Circle No 572

DIGITIZERS

Century Series waveform digitizers consist of four models: an 8-bit-resolution unit that takes 1.3G samples/sec; an 8-bit unit that takes 200M samples/sec and can store 2M samples; an 8-bit unit that takes 100M samples/sec and can store 2M samples; and a 12-bit unit that takes 5M samples/sec and that, if fully expanded, can store 8M samples. These digitizers, suited to bench mounting or rack mounting, feature modular construction, which lets you add channels. You can operate additional digitizers independently or you can synchronize them to capture multichannel data. $8950 to $16,950. Delivery, four to six weeks ARO.

LeCroy Corp, 700 Chestnut Ridge Rd, Chestnut Ridge, NY 10977. Phone (914) 425-2000. TWX 710-577-2832. Booth Nos 2211 and 2213.

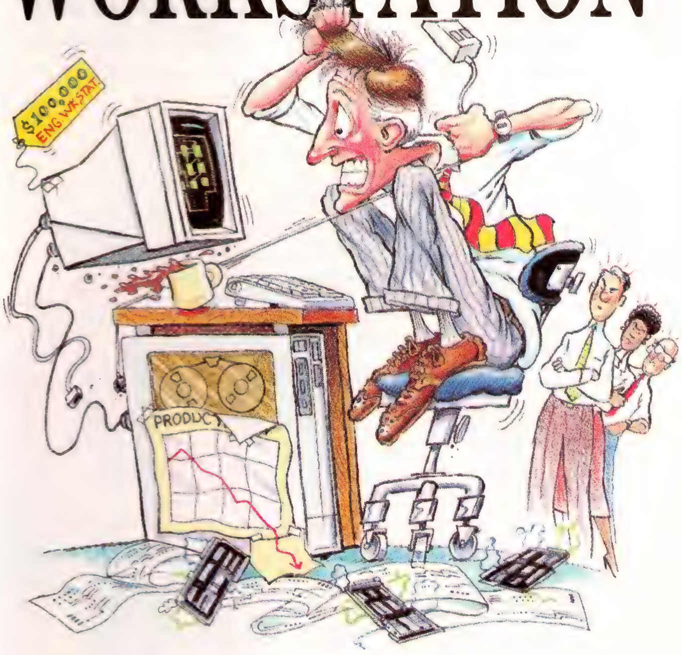
Circle No 571



SPECTRUM ANALYZER

The 2383 spectrum analyzer covers 100 Hz to 4.2 GHz. It offers a 3-Hz min resolution bandwidth and a ±1.5-dB accuracy at 4.2 GHz. A tracking generator prevents frequency drift from impairing synchronous swept measurements. An FM demodulator allows display of demodulated audio signals. An active probe permits the instrument to make high-impedance measurements at frequencies as high as 1.25 GHz. On a single screen, the analyzer can display a full-band sweep covering 100 Hz to 4.2 GHz. The residual responses are −110 dBm, and the intermodulation equals <−90 dBc. The analyzer's IEEE-488 port lets you dump displayed spectra to plotters and storage devices. $41,950. Delivery, 60 days ARO.

GOODBYE WORKSTATION



It's time to say goodbye to expensive engineering workstation based CAD systems. Why should management tie up $100,000.00 or more in a workstation when the same (and often better) performance is obtained with **PADS-PCB**, a PC based CAD system?

PADS-PCB is a high performance printed circuit board design software that offers a degree of functionality a designer could expect only from an expensive engineering workstation.

CIRCLE NO 11

Marconi Instruments, 3 Pearl Ct, Allendale, NJ 07401. Phone (201) 934-9050. Booth Nos 2509 and 2511.

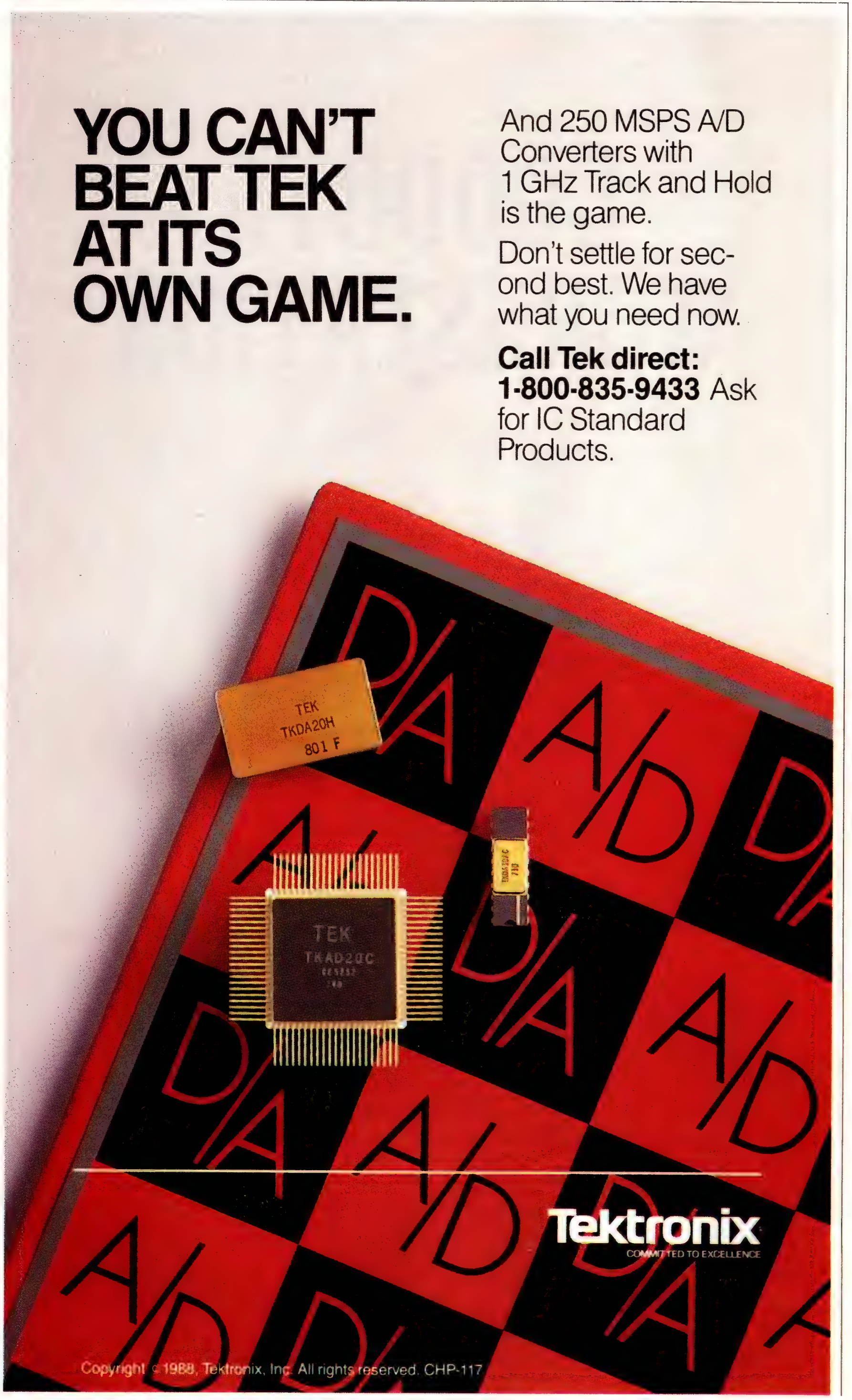
Circle No 573

DATA RECORDER

The RTP-650A instrumentation tape recorder records 14 channels of dc-to-40-kHz information and a voice channel on standard Beta-format cassettes. You can trade off recording time for bandwidth: When operating in the standard FM mode at the maximum tape speed, the unit records 40-kHz data for 3.3 minutes with a 47-dB S/N ratio; when running in this mode at the lowest tape speed, it records 625-Hz data for 3 hours and 28 minutes with a 39-dB S/N ratio. If the unit is operating in the optional direct-record mode at the maximum tape speed, the bandwidth extends from 200 Hz to 150 kHz with a 30-dB S/N ratio; if the unit is running at the slowest tape speed in the same mode, the bandwidth extends from 100 Hz to 2.35 kHz with a 26-dB S/N ratio. The vendor offers the unit with an option that enables it to perform PCM recording that conforms to IRIG 106-80. $35,750.

Kyowa Dengyo Corp, 81 Ruckman Rd, Closter, NJ 07624. Phone (201) 784-0500. TLX 135067. Booth No 2925.

Circle No 574



YOU CAN'T BEAT TEK AT ITS OWN GAME.

And 250 MSPS A/D Converters with 1 GHz Track and Hold is the game.

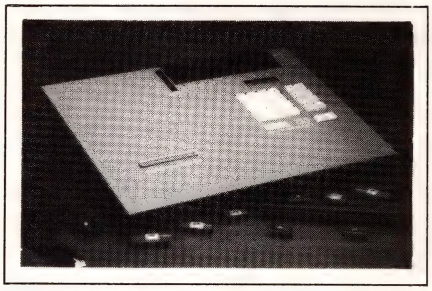
Don't settle for second best. We have what you need now.

Call Tek direct: 1-800-835-9433 Ask for IC Standard Products.

Tektronix
COMMITTED TO EXCELLENCE

Copyright © 1988, Tektronix, Inc. All rights reserved. CHP-117

CIRCLE NO 12

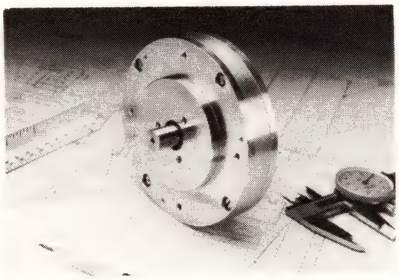


PROGRAMMER

The 135 Multiprogrammer functions as a gang EPROM duplicator or as a set EPROM programmer. It can program as many as eight 24-, 28-, or 32-pin devices simultaneously; you can obtain the unit with an option that enables it to accommodate 16 devices. The vendor can configure the unit to accommodate 40-pin EPROMs, 40-pin programmable microcontrollers, 3-voltage EPROMs, PLDs, EPLDs, GALs, and bipolar PROMs. When you use the unit as a set programmer, it can program 16- or 32-bit words disposed in two or four devices. The unit includes a 256k-byte memory, which you can expand to 2M bytes; a 25-key keypad; a 16-character×2-line alphanumeric liquid crystal display; a parallel printer port; and an RS-232C interface operable at speeds as high as 19,200 bps. $1195.

Bytek Corp, 1021 S Rogers Circle, Boca Raton, FL 33487. Phone (305) 994-3615. TLX 4998369. Booth No 2954.

Circle No 575



SERVOMOTOR

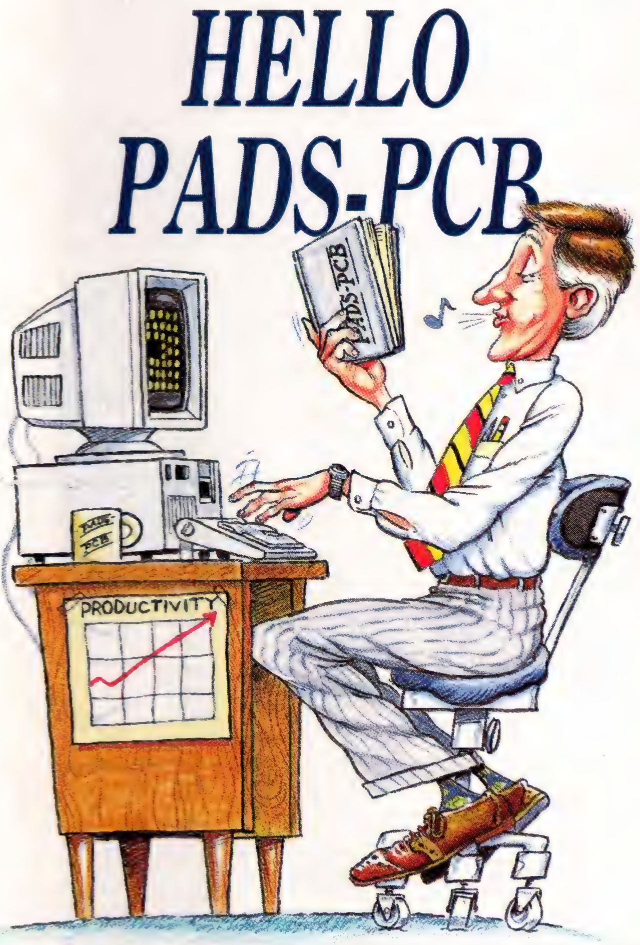
The 4.38-in.-wide, 0.92-in.-thick N Series servomotors produce 69 oz-in. of torque over 0 to 4000 rpm. They provide a peak torque of 755 oz-in. The motors rotate without cogging even at low speed. Their rated terminal voltage equals 30V, and their rated current is 7.9A. They feature 0.85Ω terminal resistance and <100-μH armature inductance. Their moment of inertia ranges from 0.396 to 0.586 kg-cm^2. One motor in the series has a tachometer output that produces 3.5 V/krpm. $550. Delivery, eight to 10 weeks ARO.

PMI Motion Technologies, 49 Mall Dr, Commack, NY 11725. Phone (516) 864-1000. TWX 510-223-0007. Booth No 432.

Circle No 576

CAE SYSTEM

EE Designer III is a complete CAE software package that runs on the IBM PC/AT, PC/XT, and compatibles. The software supports 2M bytes max of expanded memory and lets you design pc boards as large as 32×32 in. and with as many as 36 layers. You can include as many as 64,000 connection segments and 64,000 text strings. The schematic design module provides for forward and back annotation of multipage schematics to the layout, and for automatic parts packaging of gates with pin numbers and part identification. The on-line net-list-generation feature automatically adds parts to the net list as you incorporate them into your design. The system lets you edit, copy, and mirror symbols. The simulation module handles both analog and digital circuits, and can simulate as many as 50 nodes simultaneously. The layout module allows you to edit and view as many as 16 layers simultaneous-



Powerful auto/interactive features are a part of what makes PADS-PCB the best selling CAD system on the market:

- 1 mil database-32″x32″ board size-30 layers
- Large circuit capabilities: In excess of 400 equivalent 14 pin IC's
- Automatic and interactive component placement aids
- Automatic and interactive track routing
- Automatic design rule checking
- Superior Surface Mounted Device capability
- Superb analog design capability
- One, two, and three track capability between IC Pins
- Inputs from Futurenet, Orcad, Schema, PADS-CAE and others
- 100% routing with PADS-SuperRouter, the only rip-up and reroute router on a personal computer

Call for a **free** evaluation package. Our Sales Hotline is **(800) 255-7814** in Massachusetts **(617) 486-9521.**

CAD Software, Inc.

CIRCLE NO 13

TWISTITE™

MAGNET WIRE

For superior performance and tighter control over twisted wire construction.

Developed for use in the production of custom toroid, ferrite or recording head coils, specialty audio and R.F. transformers, TWISTITE offers a number of distinct advantages.

TWISTITE is custom produced to offer a wider range of twisting construction. Manufacturing capabilities include:

- Up to 33 Twists Per Inch on fine wire.
- Twisting tolerance as tight as ±1%.
- Tightly controlled capacitance, inductance and impedance characteristics.
- Up to 10 colors in some sizes for conductor identification.
- Huge selection of insulations: NEMA MW 1000, JW1177, 105–220°C (single through quadruple film builds).
- Wide range of sizes: 24 AWG and finer.
- Wide variety of conductor materials: copper, silver, plated conductors, and special alloys.

Call or write for your free copy of our Technical Data Booklet and Capabilities Brochure. Both contain valuable information on all wire produced and inventoried by MWS Wire Industries. Samples of TWISTITE are available upon request.

1968 • 1988
20th
ANNIVERSARY

MWS
Wire Industries
31200 Cedar Valley Drive, Westlake Village, CA 91362
CALL TOLL FREE 800 423-5097
In California 800 992-8553. In L.A., 818 991-8553

TWISTITE is a trademark of MWS Wire Industries

CIRCLE NO 189

ly, with a grid resolution of 1 to 800 mils. The package includes an autorouter that minimizes the number of layers in your design. $3995.

Visionics Corp, 343 Gibraltar Dr, Sunnyvale, CA 94089. Phone (408) 745-1551. TLX 346352. Booth Nos 2838 and 2840.

Circle No 577

DEBUGGER

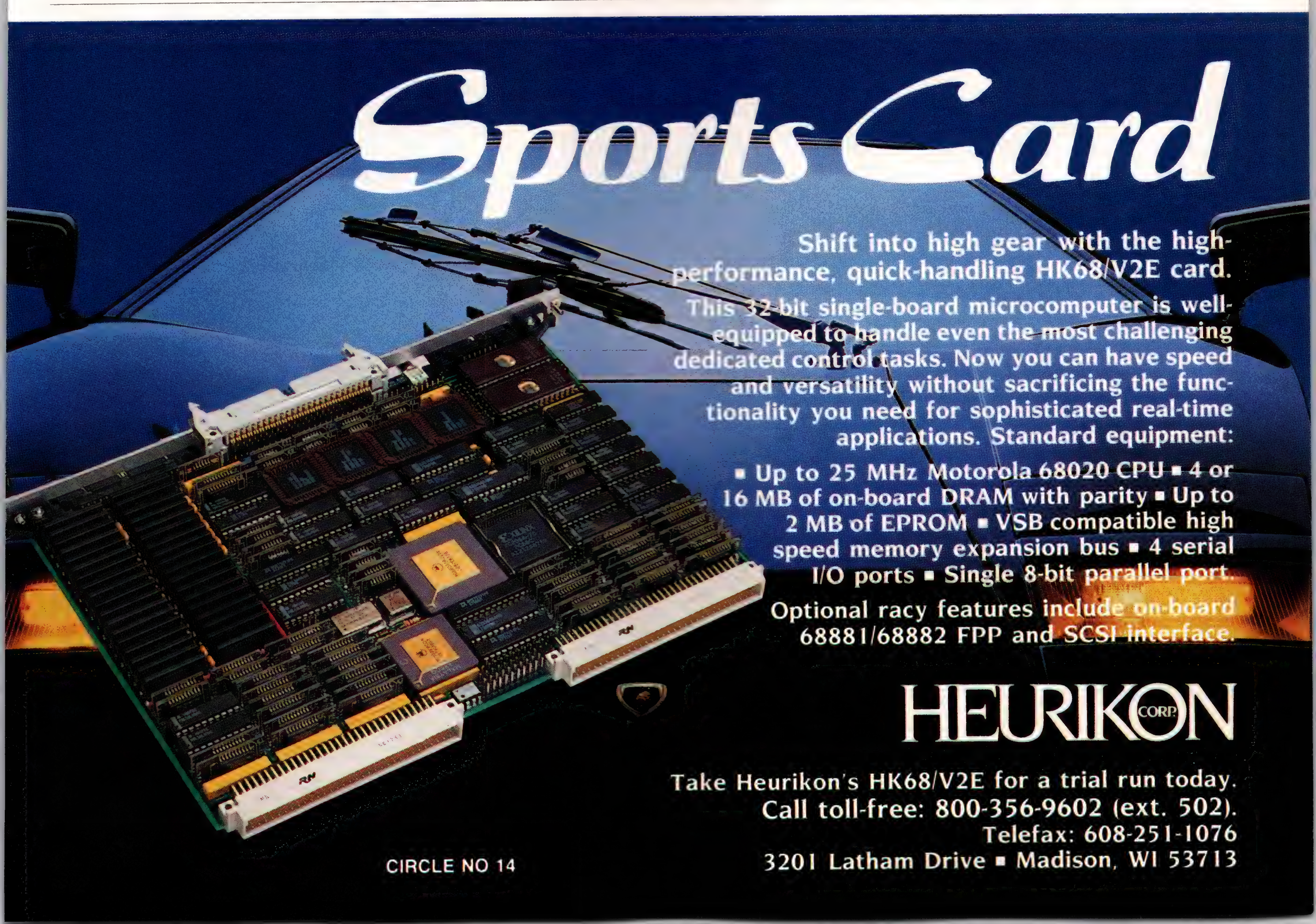
The Xray68K high-level debugger/simulator package runs on a variety of host computers and generates code for the Motorola 68000 family of µPs. The package includes the MCC68K C cross-compiler, a relocating macro crossassembler, a linking loader, and a library utility. You can write your application in C, using your standard editor, and then assemble and link it to generate native code for the target machine. The debugger/simulator emulates the target machine in software and allows you to control and examine the execution of your code either at the assembly-language level or in terms of C source-code lines. You can set both simple and complex breakpoints and display both interrupts and user I/O operations. Alternatively, you can direct simulated target output to a disk file for later examination and analysis. From $3500 to $14,000.

Microtec Research Inc, 3930 Freedom Circle, #101, Santa Clara, CA 95054. Phone (408) 733-2919. TLX 4990808. Booth Nos 2619 and 2621.

Circle No 578

SCHEMATIC CAPTURE

The HiWire-Plus schematic-capture software package runs on the IBM PC and compatibles and has been enhanced by the addition of an ECL component library and a ladder-diagram library. Other new features include 0.001-in. resolution, the ability to create pc-board layouts with as many as 250 layers and the ability to handle boards as large as 60×60 in. You can direct output to pen plotters, dot-matrix printers, and laser printers. The package includes utilities for the creation of net lists and a bill-of-materials, and for comparing these with your final board layout. The vendor offers a 3½-in. diskette version of the package for use on the IBM PS/2 family and some laptop machines. $895.



Sports Card

Shift into high gear with the high-performance, quick-handling HK68/V2E card. This 32-bit single-board microcomputer is well-equipped to handle even the most challenging dedicated control tasks. Now you can have speed and versatility without sacrificing the functionality you need for sophisticated real-time applications. Standard equipment: ▪ Up to 25 MHz Motorola 68020 CPU ▪ 4 or 16 MB of on-board DRAM with parity ▪ Up to 2 MB of EPROM ▪ VSB compatible high speed memory expansion bus ▪ 4 serial I/O ports ▪ Single 8-bit parallel port. Optional racy features include on-board 68881/68882 FPP and SCSI interface.

HEURIKON CORP

Take Heurikon's HK68/V2E for a trial run today.
Call toll-free: 800-356-9602 (ext. 502).
Telefax: 608-251-1076
3201 Latham Drive ▪ Madison, WI 53713

CIRCLE NO 14

INTEL from HAMILTON/AVNET

BUILD ON THE 32-BIT AT-BUS PLATFORM, FROM THE LEADING SUPPLIER OF 386-BASED OEM SYSTEMS

INTEL AND HAMILTON/AVNET NOW OFFER A FULL RANGE OF BUS OPTIONS FOR THE INDUSTRIAL OEM

For high-performance applications which require greater processing and memory capability as well as PC compatibility, Intel's System 301 now offers industrial OEMs the power of the 80386 microprocessor with the flexibility of the AT-bus architecture.

The system features eight I/O expansion slots, and is designed to run standard PC operating systems and applications packages. It's perfect for computer aided design, computer aided engineering and advanced financial analysis applications.

Intel's open system architecture can give your system the flexibility to accomodate future changes in technology and customer requirements. That's because Intel supports the most popular computer bus architectures — PC-bus, Multibus* I and Multibus II. Together, these three bus architectures account for almost 70% of the OEM bus market.

Finally, with the System 301 you'll get the assurance and quality you've come to expect from Intel, the world's largest supplier of 386-based OEM platforms, plus the timely delivery of quality services you've come to expect from Hamilton/Avnet's Systems Engineering Group.

Ready to start? Call any of the numbers to the right.

*Multibus is a registered trademark of Intel Corporation.

LET HAMILTON/AVNET'S SYSTEMS ENGINEERING GROUP BUILD YOUR SYSTEM FROM THE BROADEST LINE OF COMPUTER PRODUCT

Using Intel's System 301 as the foundation, Hamilton/Avnet's Systems Engineerin Group has a full series of services — an one of the best lines of computer products — to give you a completed system configured to specification and delivere on time.

We can also offer you special service such as software loading and testing drive testing and custom industria rack mounts.

For the finest computer products an the fastest professional service, talk to you local Hamilton/Avnet representative abou our Systems Engineering Group: Part o the team that builds your business.

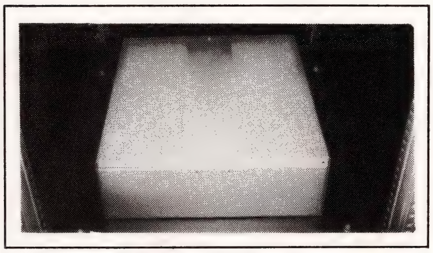
Hamilton Avnet
ELECTRONICS
AN AVNET COMPANY

TORONTO ..... (416) 677-7432
FAX NO. .... (416) 677-0940
MONTREAL .... (514) 335-1000
FAX NO. .... (514) 335-2481
OTTAWA .... (613) 226-1700
FAX NO. .... (613) 226-1184
CALGARY ...... (403) 250-9380
FAX NO. .... (403) 250-1591
VANCOUVER ... (604) 437-6667
FAX NO. .... (604) 437-4712
OR, TOLL FREE ... 1 (800) 387-3406

CIRCLE NO 191

Wintek Corp, 1801 South St, Lafayette, IN 47904. Phone (800) 742-6809; in IN, (317) 742-8428. TLX 709079. Booth No 519.

Circle No 579



IMPELLER BLOWER

The 803N-2 motorized impeller blower comes in a smaller, more efficient package than do centrifugal blowers. The blower is balanced in two planes to ensure minimum vibration, and you can mount it in any position. The motor and bearings are sealed to provide maintenance-free operation. If you mount the blower on the floor of the equipment frame, you must maintain a $\frac{15}{16}$-in. clearance between the frame base and the floor for air intake. The blower operates on 115V ac at 50/60 Hz and draws 1.18 amps. Its speed is variable between 2200 and 2570 rpm, and it delivers 445 to 540 cfm at a noise level of −55 dB. The blower case, which also contains a filter, measures 5×14.5×13.5 in. $265.

Amco Engineering Co, 3801 N Rose St, Schiller Park, IL 60176. Phone (312) 671-6670. TWX 910-227-3152. Booth Nos 1308, 1310, and 1312.

Circle No 580

CMOS BACKUP

µPowerCell 2.8V lithium-iodine batteries feature a shelf life of over 20 years at temperatures below 37°C. The vendor offers them in two configurations, round or rectangular. The round, axial-lead B-35 features 35-mAh capacity and comes on sequenced tape reels for automatic insertion. The rectangular B-400, B-600, and B-1000 have capacities of 400, 600, and 1000 mAh, respectively. The batteries operate over −55 to +125°C. The vendor also offers the DRM and DRM2 data-retention modules, which provide battery-switchover capability, and the NVRM (nonvolatile RAM module), which features 2k bytes of Toshiba static RAM in addition to the switchover capability. B-35, from $3 (100).

Catalyst Research, 1421 Clarkview Rd, Baltimore, MD 21209. Phone (301) 296-7000. TLX 898095. Booth No 1269.

Circle No 582

The HK68/V30 is the card you've been dreaming of.

This fully-loaded single-board VME microcomputer combines the highly sought-after qualities of high speed and advanced on-card functionality. Now you can have high-end performance for UNIX and real-time applications. Standard equipment:

▪ Up to 25 MHz Motorola 68030 CPU ▪ 4 or 16 MB of on-board DRAM with parity ▪ Up to 1 MB of EPROM ▪ 2 serial I/O ports ▪ Single 8-bit parallel port ▪ Mailbox interrupt support.

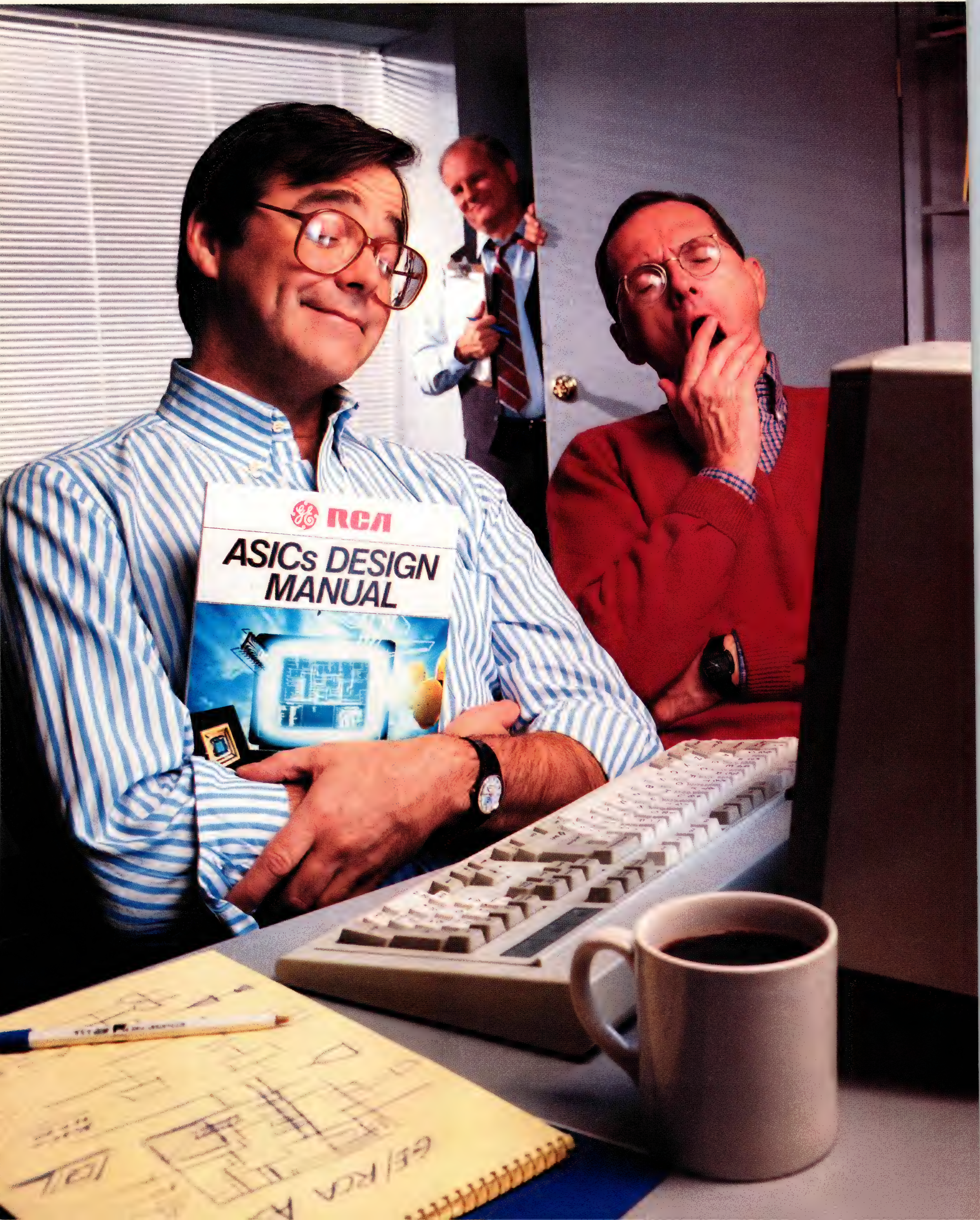
Optional equipment includes on-board 68881/68882 FPP, SCSI interface and Time-of-Day clock with battery back-up.

HEURIKON CORP.

Take Heurikon's HK68/V30 for a grand tour today.
Call toll-free: 800-356-9602 (ext. 503).
Telefax: 608-251-1076
3201 Latham Drive ▪ Madison, WI 53713

CIRCLE NO 15

Our ASICs



are boring.

They're easy to design. They're ready on time. And first-time success is virtually 100%.

You've heard all about the excitement of ASICs.

They improve performance, lower costs and make many new designs possible.

But, unfortunately, you've probably also heard about one big potential problem: while many ASICs pass the tests specified by the designer, they don't always work in the real world. And that causes excitement you can do without.

How to get first-time success.

It starts with our Design Simulation Software. It's been rated the best in the industry by the people who should know—designers who have used it. Within three days, you can be up to speed, working at any of the major workstations in the industry, creating and revising your ASIC with ease.

The standard cell advantage.

You'll really appreciate the power of our standard cells, which allow you to integrate a whole system, including macros, memories, logic and peripherals, onto a single chip.

We have cells with effective gate length as small as 1.5µ (.9µ coming soon). And double-level metal for higher-density chips that can handle higher clock speeds.

You can choose from a wide range of Supercells, including the leading-edge RS20C51 core micro, RAMs, analog functions, bit-slice processors, HC/HCT logic, Advanced CMOS Logic, and high-voltage cells.

If they aren't enough, we can even generate Supercells to your specs.

And we're also in the forefront of silicon compiler technology. So we can offer you the ability to create designs that are heavily BUS-structured, with your ROMs, RAMs, PLAs and ALUs compiled right into the design.

We also bring you the resources of some very powerful partners, thanks to our alternate-source agreements with VLSI on standard cells; WSI on macrocells and EPROMs; and a joint-development agreement with Siemens and Toshiba on the Advancell® library of small-geometry cells.

Gate arrays, too.

If gate arrays are better for your design, you'll be able to choose from our full line up to 50,000 gates, with effective gate length as small as 1.2µ and sub 1 ns gate delays.

These gate arrays use "continuous gate" technology for up to 75% utilization. They are an alternate source to VLSI Technology arrays.

We also alternate source the LSI Logic 5000 series.

And we have a unique capability in high-rel ASICs, including SOS. Our outstanding production facilities here in the U.S. produce high-quality ASICs in high volume at very low costs.

It almost sounds exciting for something so boring, doesn't it?

For more information, call toll-free today 800-443-7364, ext. 25. Or contact your local GE Solid State sales office or distributor.

In Europe, call: Brussels, (02) 246-21-11; Paris, (1) 39-46-57-99; London, (276) 68-59-11; Milano, (2) 82-291; Munich, (089) 63813-0; Stockholm (08) 793-9500.

*

GE Solid State

GE/RCA/Intersil Semiconductors

Three great brands. One leading-edge company.

*Trademark of General Electric Company, U.S.A., not connected with the English Company of a similar name.

CMOS
DATA BOOK
CYPRESS SEMICONDUC
Systems Design Handbook
SECOND EDITION
Programmable Logic Data Manu
HIGH PERFORMANCE CMOS DATA
FACT DATA BOOK
MOS Memory Data Book
1986
National Semiconductor
Handbook/Data Book
Commercial/Military
1987
Commercial/Military
1986 Data Book
VIEW
MONDAY

Highest performance designers know where to turn.

Our customers design the world's highest performance computer-based products.

It's hard work. We make it easier, with a large variety of the highest performance ICs. All in cool, low power CMOS, delivered in small, space-saving packages.

That's why when you visit any design lab where highest performance is critical, you'll likely find a very well-worn Cypress Semiconductor databook.

Highest performance designers turn to our specs for fast solutions to tough design problems.

They specify our parts with confidence, because we take pains to out perform our own specs.

CMOS High Speed Logic Family:

The world's fastest 16-bit-slice, our 7C9101, for starters. Our Logic Family also includes the fastest available 64 x 8 to 2K x 9 cascadeable FIFOs (35MHz performance). Our databook will also show you lightning-fast 4-bit-slice parts, 12-bit controllers, 16 x 16 multipliers, and more.

CMOS High Speed SRAM Family:

Featuring our blazing, 12ns 4K and 7ns 1K TTL-compatible SRAMs. Plus a variety of 15ns, 25ns, 35ns, and 45ns parts, too. Nibble-wide, bit-wide, byte-wide, ranging from 64-bits through 64K-bits. Plus, our 8K or 16K 25ns dual-port SRAMs.

CMOS High Speed PROM Family:

Surpassing bipolar with the *fastest* registered PROMs at HALF bipolar power. Parts feature speeds to 18ns set-up, 12ns clock-to-output, all with low CMOS power. Byte-wide family available in 4K, 8K, 16K, 64K, and 128K densities! Windowed versions available for convenient reprogrammability. All available in space-saving, money-saving skinny DIP 300 mil packages.

CMOS High Speed PLD Family:

Our 25ns Quarter-Power 55mA windowed 22V10 EPLD has set the performance standard for programmable logic. Now, we're introducing our new PLD 7C300 family, functionally partitioned to address specific application needs. Synchronous, Asynchronous, or Combinatorial versions bring unprecedented gate utilization and programming flexibility, yielding twice the performance and density, using only half the power of previous PLD generations.

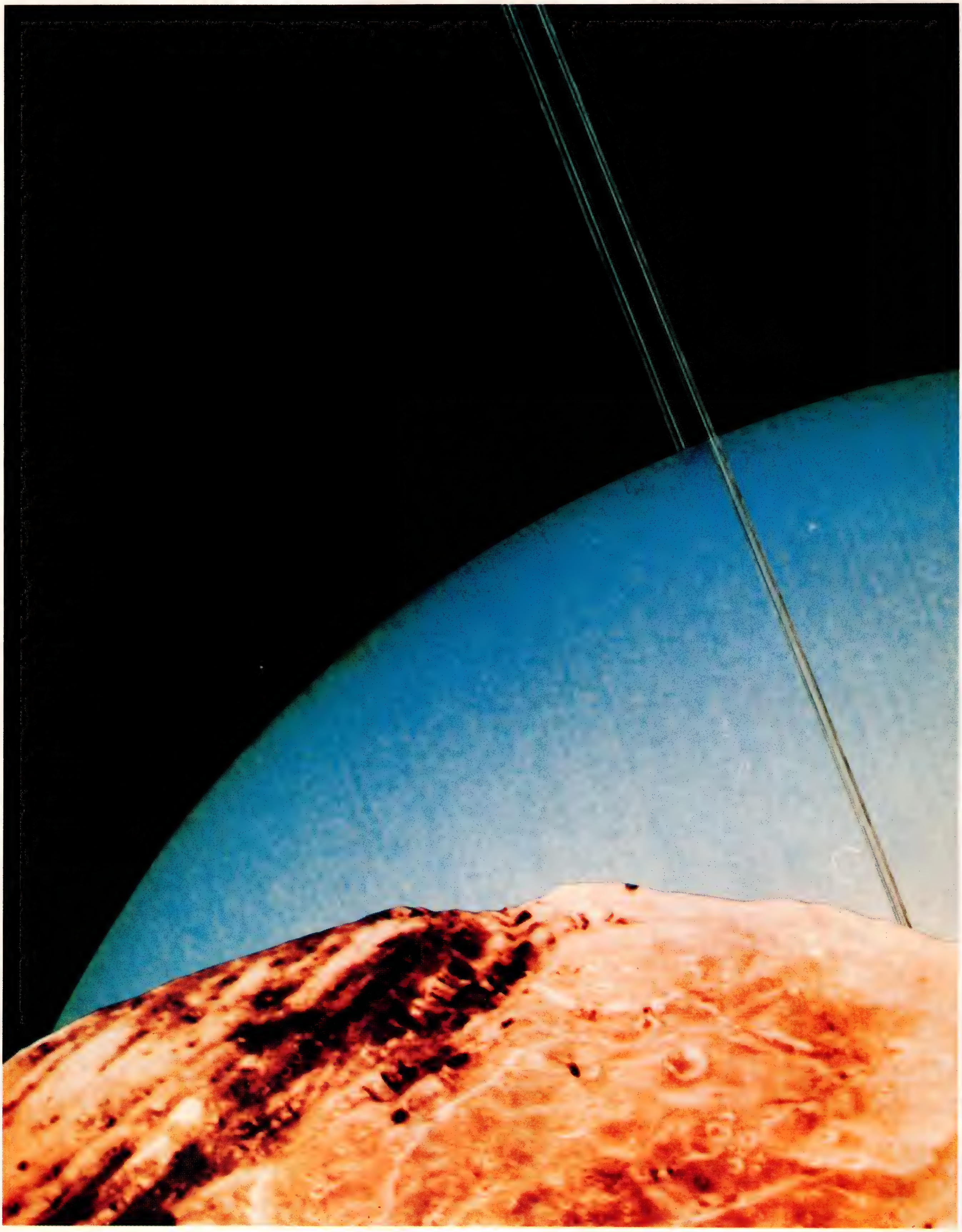
And now, the new DataBook.
Yours free, for a toll-free call.

DataBook Hotline:
1-800-952-6300
Ask for Dept. C41
1-800-423-4440 In CA
Ask for Dept. C41
(32) 2-672-2220 In Europe
(416) 475-3922 In Canada

CMOS DATA BOOK
CYPRESS SEMICONDUCTOR

CYPRESS SEMICONDUCTOR

Cypress Semiconductor, 3901 North First Street, San Jose, CA 95134, Phone: (408) 943-2666, Telex: 821032 CYPRESS SNJ UD, TWX: 910-997-0753. ©1988 Cypress Semiconductor.



Nine years and approximately 1,750,000,000 miles from the nearest service depot *on Earth, Voyager 2 photographed Uranus, its rings, and its moons, including the moon Miranda (shown in the foreground of this composite photo). Missions such as those of the Voyager spacecraft underscore the need for ultrareliable space systems. Voyager 2 will fly by Neptune in August 1989. (Photo courtesy Jet Propulsion Lab/NASA)*

PART FIVE
DECADE 90
The future of
system design

Fault-tolerant design spans terrestrial and space applications

The growing commercialization of space will boost many more electronic systems into orbit in the 1990s. Fault-tolerant design techniques developed originally for aerospace systems will pervade the electronics industry as customers demand the utmost in reliability from every electronic product, even those intended for use on Earth.

Steven H Leibson, *Regional Editor*

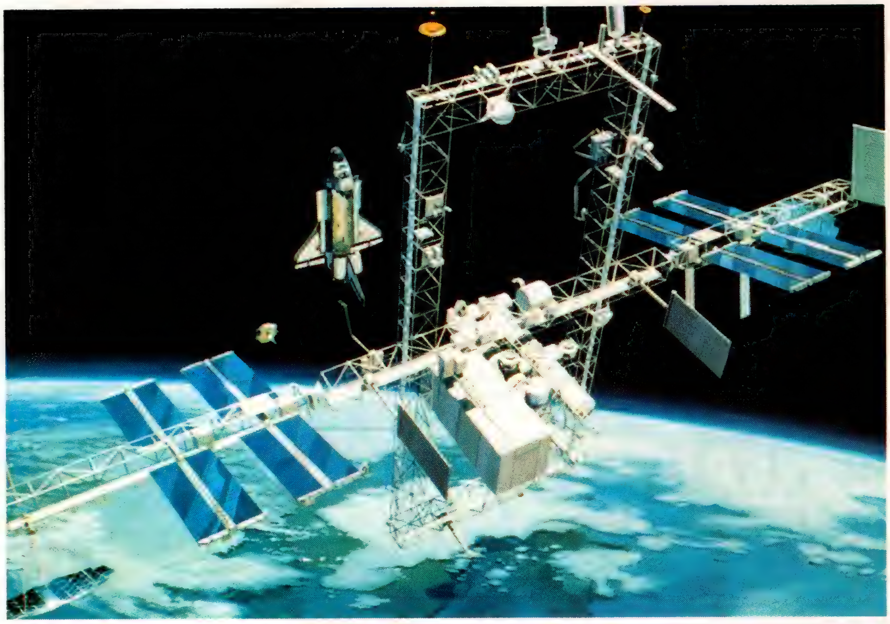
Space has been a commercial frontier for more than 20 years, thanks to communications satellites. In the 1990s, a lot more hardware is headed off Earth both to enhance existing communications facilities and to expand the commercial use of space into other areas. President Reagan recently revealed a new space initiative that calls for increased commercialization of space, and several companies are now deeply involved in plans to make that vision real. As a result, during the next decade, engineers will design many more electronic systems for spaceborne applications than they have in past years.

Systems for use in space must meet stringent reliability requirements. They must also withstand the unusual environmental hazards present in space, such as temperature extremes and radiation. What's more, as electronics spreads throughout earthbound applications, any system that plays a vital role in the health and welfare of human beings will have to meet requirements similar to those for spaceborne systems. Whether they're designing systems for use in space or on Earth, therefore, more engineers will have to become better acquainted with fault-tolerant design.

Space presents immediate challenges

The US's permanently manned space station, which NASA plans to make operational by 1997, represents a major opportunity for progress in space electronics. Just for its construction, the station requires extensive development of automated systems that manage data, environmental-control, life-support, thermal, and power systems. NASA divided the space-station project into four work packages and, last December, awarded contracts for these packages to Boeing Aerospace Co (Huntsville, AL), McDonnell Douglas Astronautics Co (Huntington Beach, CA), the Astro-Space Div of General Electric Co (Valley Forge, PA), and the Rocketdyne Div of Rockwell International (Canoga Park, CA).

In February 1988, President Reagan revealed a new space policy that plays up the role of private companies in US space efforts. In fact, firms in the US such as Space Services Inc (Houston, TX), with its Conestoga Series small boosters, are already attacking the first major hurdle—cost-effective access to orbit—by developing independent launch systems to supplement US



The US's permanently manned space station, *which is scheduled to become operational in 1997, presents several opportunities for designing fault-tolerant systems that manage data, environmental-control, life-support, thermal, and power systems. In addition, the space station will provide a platform for conducting manufacturing-related investigations, which will also require fault-tolerant systems to oversee the experiments. (Photo courtesy NASA)*

government vehicles. One forward-looking company, Orbital Transport Services Inc (Phoenix, AZ), is developing an electromagnetic catapult that employs superconducting storage rings to provide the electrical energy for launching a payload into orbit.

A space station smaller than NASA's planned one, the industrial space facility (ISF) designed by Space Industries Inc (Houston, TX), is scheduled to become operational in 1991, much earlier than the manned space station. The unmanned ISF will provide a platform for materials research and automated manufacturing. Unlike the manned space station, it will not incorporate life-support systems, but will be visited occasionally by the space shuttle for repairs, supplies, and retrieval of manufactured products.

Many other countries, attracted by the potential profits in satellite delivery, have entered the space-transportation business. The European Space Agency (ESA) has already launched several payloads with its Ariane booster series, and has recently decided to build an improved model—the Ariane 5—as well as the Hermes space shuttle and the Columbus manned space laboratory. China and the USSR have also entered the competition by selling rides on their respective Long March and Proton heavy-lift boosters. Japan, though not yet in the fray, is currently developing a commercial launch vehicle of its own. Consequently, a lot of electronic hardware will be heading for space during the 1990s.

Though more electronic systems will end up in space during the 1990s, many engineers today lack the expertise to design systems for extraterrestrial environments. Electronic systems in space applications must tolerate radiation, and few engineers are familiar with the components and techniques necessary to build radiation-resistant circuitry (see **box,** "Proofing electronic systems against radiation").

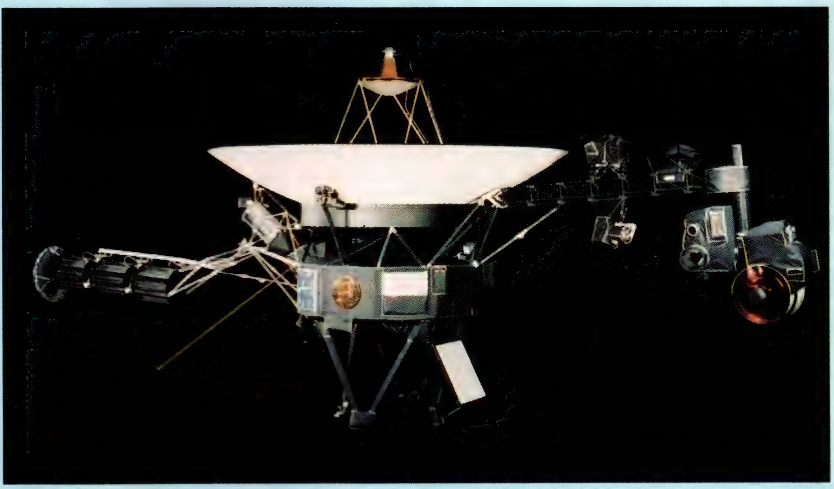
Space hardware must also be very reliable, because on-site service is either very costly or unavailable. Furthermore, most space equipment must be robust enough to handle unplanned problems without human intervention. Today, engineers developing equipment for aerospace applications are some of the world's leading experts on fault-tolerant, redundant design.

Aircraft need fault tolerance

According to Gary Kravetz, vice president of engineering at Fail-Safe Technology Corp (a consulting firm specializing in reliable-system design), engineers first started using fault-tolerant and fail-safe designs for aircraft flight-control systems in the 1960s. At that time, aeronautical engineers were starting to design inherently unstable airframes, such as that of the F-16 fighter, that required a computer to dynamically position the control surfaces for stable flight. The control computers had to be absolutely reliable, because computer failure in such applications results in catastrophic consequences—the plane will fall out of the sky.

Proofing electronic systems against radiation

Besides requiring reliability, redundancy, and robustness, spaceborne systems encounter an environmental hazard not common to most terrestrial applications: radiation. All ICs tolerate radiation to some extent, but because manufacturers are always trying to optimize other characteristics such as yield or speed in their commercial parts, chips that are not specifically hardened against radiation may not have repeatable radiation tolerance from lot to lot. Engineers confer hardness on a design by using special device geometries and spacings and by fabricating the chips with carefully controlled processes.



Voyager's mission posed some tough challenges *for designers trying to harden the spacecraft's electronic systems against radiation. One such challenge presented itself in the form of reports from Pioneer 10 and 11—a year after the Voyager design was finished—that the radiation intensity in the vicinity of Jupiter was 1000 times greater than experts had estimated. The discovery required Voyager's designers to provide the craft with additional radiation hardening. (Photo courtesy JPL/NASA)*

Spurred by the US government's requirements for radiation-hardened devices in military and space applications, several companies now offer ICs specifically built for high-radiation environments. For example, Harris Semiconductor (Melbourne, FL), offers several lines of rad-hardened analog and digital ICs. The company even offers a hardened version of the Intel 8086 μP, which Ball Aerospace Systems Div (Boulder, CO) has incorporated in its subsystem processor, a computer subsystem that Ball plans to use as a controller in future spacecraft designs.

The United Technologies Microelectronics Center Inc (UTMC, Colorado Springs, CO) also offers rad-hardened ICs. The company makes both standard parts and ASICs for systems that must tolerate radiation. Recently, UTMC introduced the UTD-R family of gate arrays, which meets all of its data-sheet specifications after absorbing a 1M-rad (Si) dose of radiation. That's about the radiation dosage an unshielded system must endure while orbiting the Earth for 10 years.

Different types of radiation (neutrons, ionizing radiation, and heavy ions) affect semiconductors differently. In addition, different dose rates create varying effects. Because device physicists don't yet fully understand all of the changes that different types of radiation produce in semiconductors, few standards for testing an IC's radiation hardness exist. Most of the existing standards were created by the US Department of Defense.

Rad-hardened-system design has remained a rather esoteric field that's limited mostly to military and space applications. However, because of the growing number of electronic systems in space, more engineers will need to develop expertise in rad-hard design. The IEEE's Nuclear and Plasma Sciences Society serves as an excellent source of information concerning radiation effects on electronic devices. The society sponsors an annual Nuclear and Space Radiation Effects Conference (NSREC) that includes a short course on rad-hard design methods for the uninitiated. This year's conference will take place in Portland, OR, from July 11 to 15. For more information about the 1988 NSREC, contact Bobby Buchanan at Spire Corp (Bedford, MA, (617) 275-6000).

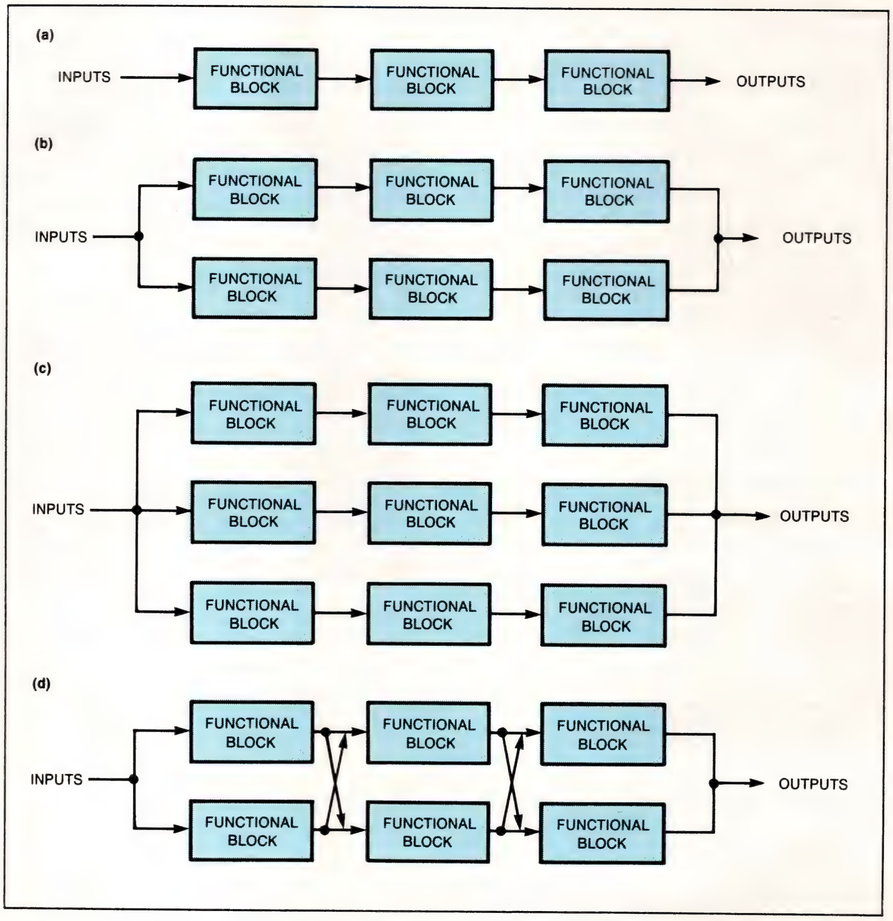


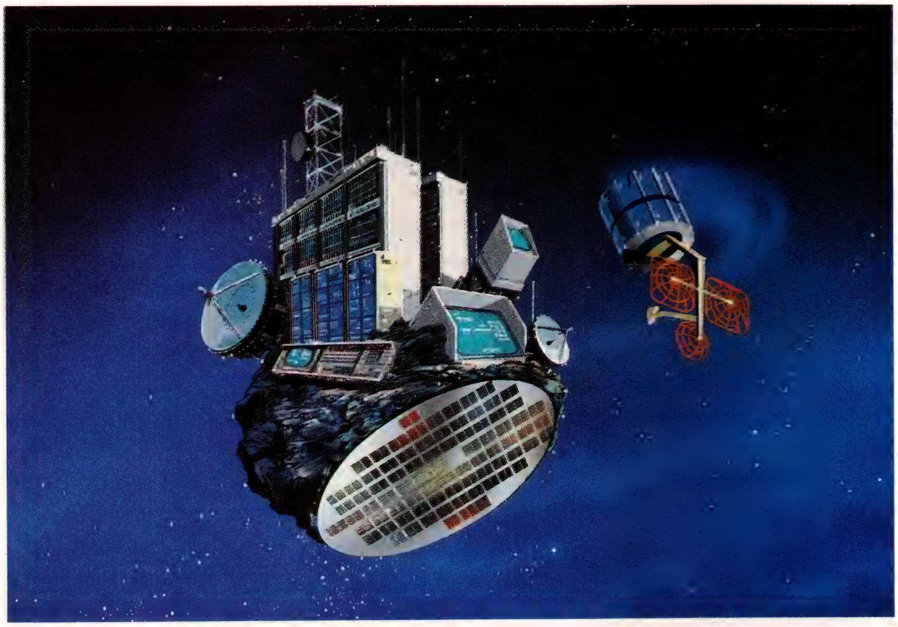
Fig 1—You can represent a complex system as a string of functional blocks, *assign the string a reliability figure, and then compute the expected failure rate for the entire string **(a)**. Should that figure not meet your system specs, you can add a parallel, redundant system **(b)**, or even two of them **(c)**, to boost the overall system reliability. To achieve even greater reliability, usually at lower cost, spacecraft designers often use cross-strapping, which allows one system to use functional components from another system in case of a failure **(d)**.*

Kravetz says that spacecraft requirements for electronic control systems vary according to the mission. The first orbiting satellites had fairly simple electronic systems, because they could rely on human ground controllers to rectify problems by radio control. Attitude controls, however, were made fail-safe so that a control-system failure would not plunge the satellite into the atmosphere before the ground crew could correct the fault.

Ball Aerospace Systems Div (Boulder, CO) specializes in building unmanned orbital spacecraft. William H Follett, deputy director of spacecraft systems at Ball, says that the aerospace industry has developed several approaches to improving system reliability. For example, you can represent a complex system as a series of functional blocks, assign a reliability figure for the string, and then compute the expected failure rate for the entire string **(Fig 1a)**. Should that figure not meet your system specifications, you can add a parallel, redundant system **(Fig 1b)**.

If that step does not achieve the desired system reliability, you could add another redundant system to the design **(Fig 1c)**, but spacecraft designers often use a different approach, cross-strapping, which allows one system to use functional components from another system in case of a failure **(Fig 1d)**. Cross-strapping achieves better reliability than simple replication, and it does so at a lower hardware cost than you'd incur by building systems with triple redundancy.

For orbital spacecraft, ground controllers can manually switch components into operation by using cross-strapping. Planetary probes such as the Voyager and Galileo spacecraft developed by the Jet Propulsion Laboratory at the California Institute of Technology (Los Angeles, CA), however, can't depend on ground control, because planets and other celestial objects occasionally block radio transmissions. Such spacecraft require electronic control systems that are not only fail-safe, but redundant, self-repairing, and autonomous as well.



Commercial space development in the 1990s will strengthen *the communications systems already in orbit and will initiate the era of manufacturing in space. Such enterprises require robust, reliable, redundant electronic systems that can manage operations, providing a less-expensive alternative to constant human attention. (Photo courtesy Motorola Inc, Phoenix, AZ)*

Robust, redundant, highly reliable systems certainly are critical for space applications. But they're important for applications on Earth, too. For example, by the early 1990s, at least one auto manufacturer will offer vehicles with drive-by-wire steering, in which there's no mechanical linkage between the steering wheel and the front wheels. Such a system requires less energy to operate than a hydraulic power-steering system does. The electronic steering subsystem in a drive-by-wire car had better be as robust, reliable, and redundant as any of the circuitry in a planetary space probe. In addition, as electronics become more pervasive in medical equipment, redundant and reliable design will be needed to safeguard a patient's health and well being.

Other applications in which lives hang in the balance include automated transportation, such as San Francisco's BART (Bay Area Rapid Transit) system, and industrial process control. Such applications demand fault-tolerant electronic systems. Moreover, after the USSR's Chernobyl disaster and the Three Mile Island scare in the US, many utility companies are retrofitting manual control systems in nuclear power plants with fault-tolerant, computer-based controls.

Computers in the loop

In the past, most designers resisted using computer-based control systems in critical control loops because the computers simply weren't reliable enough. Now, however, the highly reliable design techniques developed for aerospace applications greatly reduce that problem. Further, industrial disasters, such as explosions or fires in refineries or chemical plants, underscore the utility of fault-tolerant backup computers in emergencies that a human operator can't cope with.

In fact, even lower-risk applications benefit from fault-tolerant and fail-safe design. Tandem Computers (Cupertino, CA) has offered its highly reliable NonStop minicomputers for many years. The machines find use in such applications as transaction-processing systems (computers that process the information from automatic tellers, for instance), in which the financial institutions often determine that it's less expensive to pay for a very reliable system than it is to re-enter data lost because of a computer failure.

Reliability is cheap enough for μCs

Fail-Safe Technology Corp believes that microcomputer-based applications can also benefit from highly reliable design techniques. The company will start shipping its FS-66 series of 80286- and 80386-based, fault-tolerant, PC-compatible computers later this year. Each FS-66 incorporates two μPs and an ASIC that monitors the operation of both processors. If one processing subsystem should fail, the ASIC switches operations over to the second μP.

Fail-Safe claims that the FS-66 computers will provide 99.99% uptime and an MTBF of three years, yet will cost about the same as equivalent PCs from IBM.

Fail-Safe says that its machines will find use in critical data-processing equipment such as file servers, where the loss of one machine could stall or lose data from several tasks. In fact, NASA has expressed interest in using FS-66 computers to control experiments aboard the space shuttle, where a computer failure could destroy a multimillion-dollar experiment. Fail-Safe Technology also plans to incorporate the FS-66 technology in a single-board computer for embedded applications.

Many of the systems designed over the next decade will borrow freely from the fault-tolerant design techniques developed for space. Because of the greater number of electronic systems on Earth, because so many Earth systems need fault tolerance, and because technology of the 90s will make fault tolerance much less expensive to build into systems, you can expect designers of earthbound systems to take over the lead from aerospace designers in creating such rugged systems during the 1990s, further driving system engineers to adopt fault-tolerant design universally.

You can employ fault tolerance today

The tools and technologies needed to create highly reliable electronic systems are appearing rapidly. Soaring IC integration levels, for instance, are helping to make redundant design easier than ever for engineers who can wield the proper design techniques. And system-level CAD tools can simulate the performance of alternative designs; thus, you can iteratively improve a design to create the optimal solution. By rapidly creating software simulations of a prototypical system and testing them in simulated environments, you can find and eradicate many flaws before they creep into your hardware. Simulation also allows you to pit your designs against situations that could be very difficult or impossible to create in a physical test, but that could occur in the systems' target environment.

Testability is another key to reliable design: It lets you quickly verify prototype systems and thoroughly test freshly manufactured systems, ensuring that they contain no hidden flaws. Gigascale levels of integration make vast quantities of transistors available to designers so they can dedicate enough circuitry to test and maintenance functions. Built-in-test circuits will help functioning systems diagnose and perhaps even repair themselves before critical failures occur.

Finally, advanced packaging technologies such as SMT and TAB will help you create the very compact, lightweight systems that many future applications will require. These improved technologies will also boost intrinsic system reliability by reducing the number of interconnections in a typical system and increasing the reliability of the remaining connections.

Whether they're destined for space or for terrestrial applications, electronic systems of the 1990s will be more reliable than today's designs. Many of your customers already perceive reliability as a key differentiating factor when making purchase decisions, and that attitude will become more prevalent in the future. In fact, applications involving life-or-death situations—and applications where errors are extremely costly—absolutely require highly reliable, fault-tolerant designs. In any case, reliability will be a big selling point for almost any type of system in the next decade. The companies that recognize and act promptly to satisfy these needs will become the leading system designers of the 1990s. **EDN**

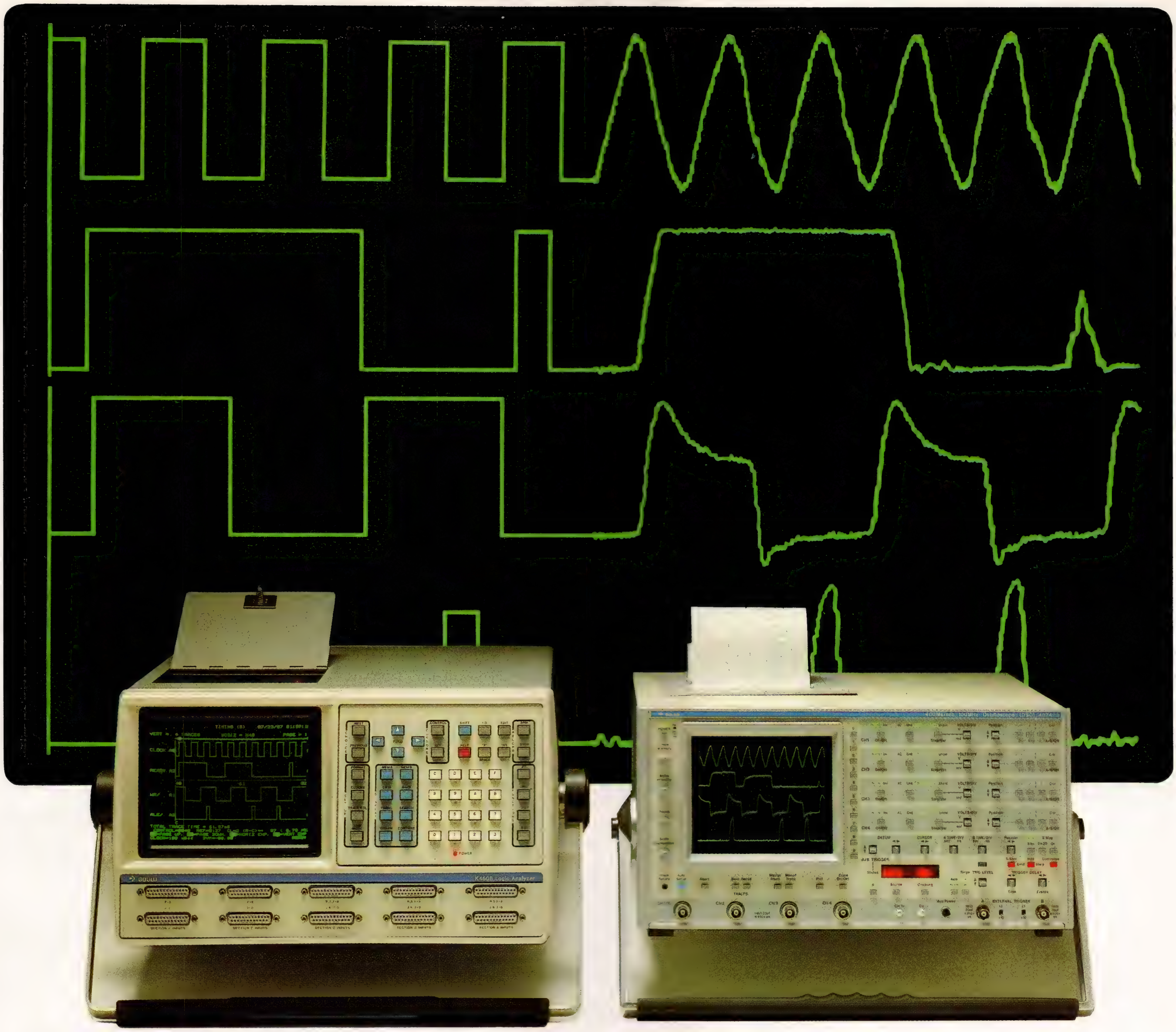
References

1. Carassa, F, Broglio, L, et al, *Quest for Space,* Crescent Books, New York, 1986.

2. Dawes, W R Jr, *IEEE Nuclear and Space Radiation Effects Conference Short Course,* July 27, 1987.

3. Stine, Harry G and Wilfred C Smith, "Laughing all the way to orbit," *Analog,* February, 1988, pg 68.

Article Interest Quotient (Circle One)
High 497 Medium 498 Low 499



The best of both worlds.

The K450B Logic Analyzer and the 4074 Digital Storage Oscilloscope from Gould…

State-of-the-art test instruments for designers of today's superfast digital and data communications systems.

Powerful measurement capabilities… The K450B Logic Analyzer, with up to 80 channels at 100 MHz or 40 channels at 200 MHz and glitch capture across all channels, provides top performance. AND the 4074 DSO—the only 4 channel instrument with 400 MSample/Sec 8 bit converters on every channel—is the most sophisticated oscilloscope available for the high speed pulse measurements required by electronics designers and test engineers. TOGETHER—they work as an integrated system without any of the compromises of hybrid systems; APART—two high performance instruments available for separate test applications.

ease of use… We provide that on both the K450B and the 4074 with our AUTO SETUP facility.

and fail-safe performance! Gould Electronics created the timing analyzer market in 1978 with the introduction of the first logic analyzer; and we were pioneers in DSO technology. Today we supply leading computer and telecommunications equipment makers with logic analyzers and DSOs for digital design verification, hardware and software integration, component and subsystem test, hardware debug and digital remote diagnostics.

Wherever high performance test and analysis is required in digital electronics design, Gould is at the leading edge with a price/performance record second to none.

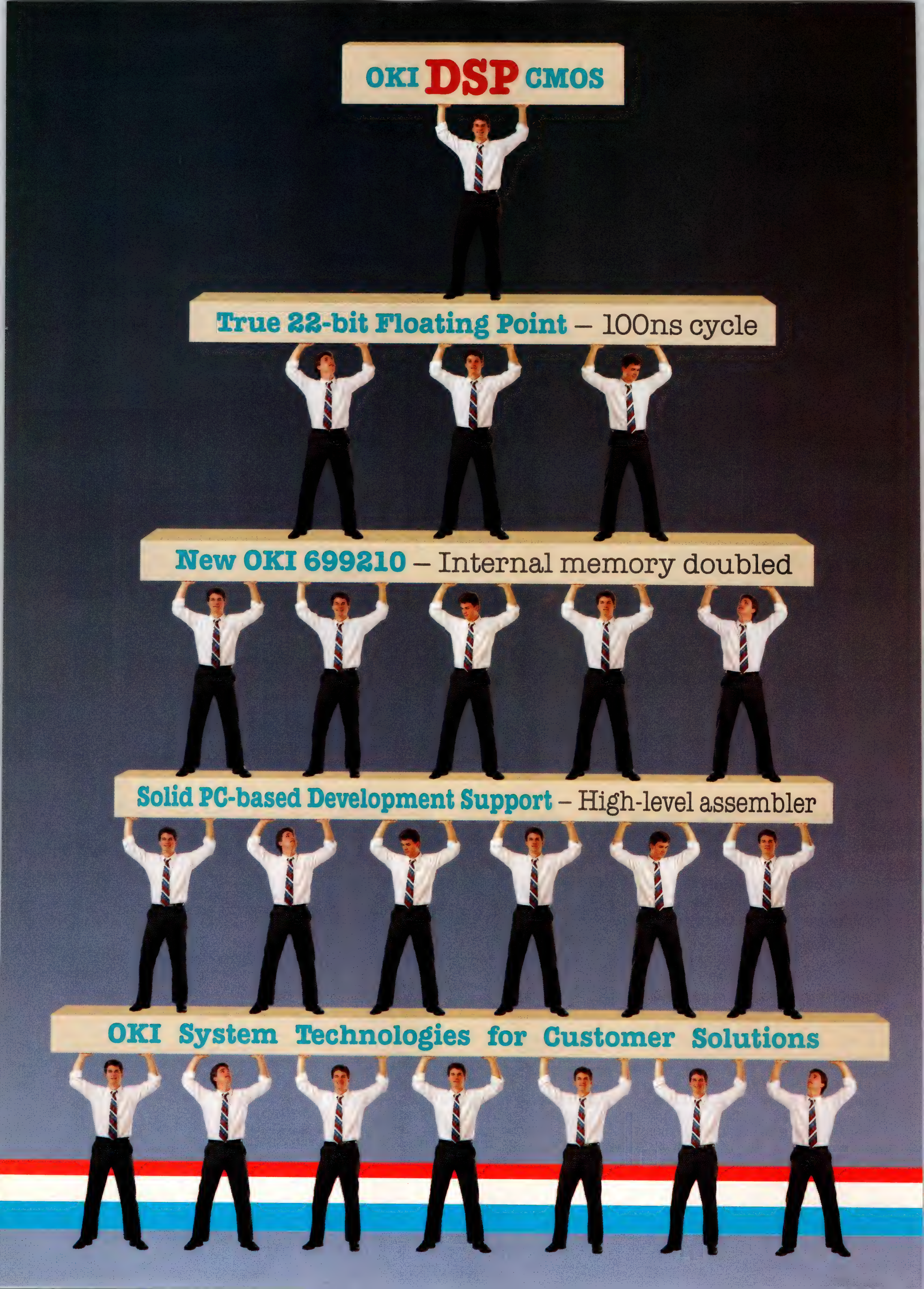
For further details, contact:

Gould, Inc.
Test & Measurement
19050 Pruneridge Avenue
Cupertino, CA 95014
1-800-GOULD 10

GOULD
Electronics

Circle 101 for info on the K450B

Circle 102 for info on the 4074


OKI DSP CMOS
True 22-bit Floating Point – 100ns cycle
New OKI 699210 – Internal memory doubled
Solid PC-based Development Support – High-level assembler
OKI System Technologies for Customer Solutions

The OKI DSP 22-bit Floating Point flexibility, on a single CMOS chip.

+ Expanded on-board RAM and ROM + Powerful instruction expansion + High-speed cycle times + Unique application ease.

OKI gives you a big lift in Digital Signal Processing. With the fastest-growing family of CMOS devices and high-level support tools on the market today. Only OKI now offers *true* floating point CMOS DSP solutions, because *we* target our system technologies to customer needs.

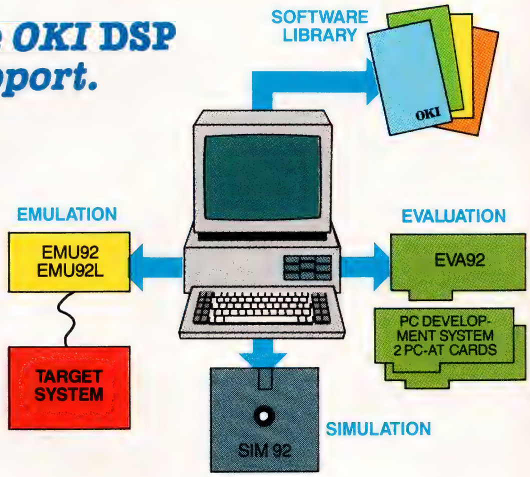
The OKI DSP chips.

Now joining our widely-applied 6992 DSP: the new *code-compatible* OKI 699**210**, setting new benchmarks in both price and performance. A 1.5 micron CMOS design, the new **210** significantly expands your DSP capabilities—at a significantly lower cost.

We built in twice as much internal memory: 512 × 22-bit words of data RAM; 2K × 32-bit words of instruction ROM. **210** instructions have been expanded to include a power-down mode, save and recover modes, as well as the ability to inhibit post-normalization. Plus programmable wait states for interfacing with slow memory.

Both single-chip DSPs, 6992 and 210, can be configured for floating point format, fixed data format or logical data format. Both offer 100ns instruction cycle times. And any code written for the 6992 can be run on the 210.

The OKI DSP support.



All our device-family innovations are enhanced by OKI's complete family of DSP support tools. These cover every development and programming function involved in any DSP design effort. Quickly, simply and cost-effectively.

Your total development process is PC-based, using OKI's own DSP hardware and software tools. Plus you can assemble in high-level mnemonics, with our Intermediate Language Assembler. Makes programming easier since the pipeline is invisible, while still producing very efficient code.

We've made debugging easier too. With SIM92/210 software for simulation, and the EVA92/210 board for evaluation. To handle emulation, we can supply an ICE for realtime development. Or use our special PC-AT cards. The first is a digital card for ICE-less emulation. The other provides 12-bit ADC-DAC conversion, with programmable sampling rates and anti-aliasing filter.

It's all here: high-level math processors plus a high-level development process. True DSP solutions, simplified by the industry's most committed system technologies.

OKI
SEMICONDUCTOR
CIRCLE NO 145

OKI DSP — Set yourself up!

Please send complete DSP technical data package for:

☐ OKI 6992 — 22-bit Floating Point CMOS DSP.

☐ OKI 699210 — 22-bit Floating Point CMOS DSP.

☐ Call me. I have immediate requirements.

Tel:(____) ________________

Name/Title______________________________

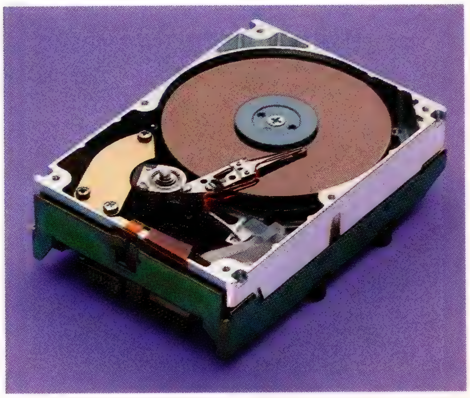
Company________________________________

EDN 042888

Please clip coupon to business card or letterhead and return to:
***DSP Customer Service*, OKI Semiconductor,**
650 N. Mary Avenue, Sunnyvale, CA 94086. **(408) 720-1900**.

"I shop the specs

because it's my job. But I buy the product because it's my career."



WHAT YOU SHOULD KNOW ABOUT THE NEW PRODRIVE™ SERIES OF 3½-INCH HARD DISK DRIVES FROM QUANTUM.

The numbers are the easy part. Either a product has them or it doesn't.

But you can't build a system out of specs.

You also need dedicated product-support people who will sit down and help you solve some tough engineering problems and put those specs to work.

Quantum is ready to deliver both.

Our new ProDrive Series of 3½-inch hard disk drives offers you the broadest range of capacities in the broadest range of interfaces in the industry. 42 and 84 megabyte formatted with embedded SCSI interface right now. And later this year, up to 168 megabytes, in SCSI, ESDI, and AT-Bus. Ten new drives in all.

All with access times of 19 ms or less.

With synchronous data transfers to the SCSI bus of 4 megabytes per second, and asynchronous data transfers of 2 megabytes per second.

With an MTBF of 50,000 hours.

And with DisCache,™ Quantum's unique 64 kilobyte data-buffering scheme that can make our 19-ms drive perform like a 12-ms drive—or even faster, depending on your application.

But Quantum also offers you the people who can help you put those numbers to work in your own system. A dedicated team of engineering professionals who understand the particular needs of the systems designer—and can help meet those needs quickly, efficiently, cost-effectively.

The new ProDrive Series. The specs you want. The support you need.

That's what Quantum delivers.

INTRODUCING THE PRODRIVE SERIES

- *3½-inch form factor*
- *42, 84, 103, 120, 145, 168 MBs formatted*
- *SCSI, ESDI, AT-Bus*
- *19 ms or faster average access time*
- *64 KB buffer with exclusive DisCache™*
- *50,000-hour MTBF*
- *42, 84 MB SCSI evaluation units AVAILABLE NOW*
- *42, 84 MB AT-Bus units available early summer '88*

Quantum

Quantum Corporation
1804 McCarthy Blvd.
Milpitas, CA 95035

ProDrive and DisCache are trademarks of Quantum Corporation.

CIRCLE NO 147

NEWS FROM PHILIPS

CRTs ☐ PASSIVES ☐ SEMICONDUCTORS ☐ INTEGRATED CIRCUITS ☐ PROFESSIONAL COMPONENTS ☐ MATERIALS

Sub-assembly brings solid-state imaging onto the shop floor

A complete sub-assembly now announced by Philips is based on the company's proprietary solid-state image sensors and requires only a lens and casing to form a complete black-and-white video camera for use in machine vision and surveillance. This is the first video camera sub-assembly incorporating a solid-state image sensor to reach the market. Manufacturers with no video equipment design experience, or with no equipment assembly facilities, can fit the sub-assembly quickly and easily into their vision systems. Philips also provides design-in support.

The unit consists of a solid-state image sensor (SSIS), and all the necessary drive, pre-processing, video-processing, and power-supply circuits. There are two basic versions for 525-line or 625-line TV systems meeting EIA or CCIR standards; these are both available in three different sensor quality grades. The sub-assembly also offers a number of options: on/off gamma; interlaced/non-interlaced signal; automatic/computer-controlled gain; automatic/manual iris lens; internal/external sync.

By simply connecting the unit to a computer, a user has the basic hardware for a machine vision or industrial inspection and control system. In such a system, the unit provides a non-interlaced signal with 610 (horizontal) by 244 (vertical) pixels – EIA standard – or 604 (horizontal) by 294 (vertical) pixels – CCIR.

In the interlaced mode, the unit can connect to monitors in security and surveillance systems for domestic, factory, traffic flow, or similar use, and then generates 610 by 488 pixels (EIA) or 604 by 588 pixels (CCIR).

The unit works down to 0.5 lux scene illumination with an f.l.4 lens. The specified signal-to-noise ratio is a high 46 dB, and the bandwidth is 5.8 MHz for −6 dB gain. All electronic circuitry is supplied on a flex-rigid printed-circuit board which can be folded or extended to meet the application requirements. Advanced surface mounting techniques reduce the size of the sub-assembly to just 89 by 40 by 42 mm with the PCB folded together or 35 by 175 by 42 with the PCB fully extended.

The unit weighs approximately 125 gram, including the power supply, and consumes a maximum of about 165 mA from a 12 V supply. Humidity, vibration, shock and bump resistance meet IEC 68-2 recommendations.

CIRCLE 150

80C51-Compatible microcontroller has twice as much ROM/RAM and an I²C-bus interface

The Philips PCB83C652 8-bit CMOS microcontroller is a derivative of the industry-standard 80C51 and has the same CPU and uses the same set of more than 100 instructions. It's a control-oriented CPU for industrial applications, instrumentation, subscriber telephone sets and consumer items. It comes in a 44-lead PLCC or a 40-pin DIL and has twice as much memory as the 80C51; 8 K bytes of program ROM and 256 bytes of volatile data RAM, both expandable to 64 K bytes off-chip. A ROM-less version is also available. An on-board interface for the world-standard I²C-bus facilitates a flexible modular approach to system designs in which other I²C-bus compatible ICs can be controlled by simply clipping them directly onto a simple 2-wire serial bus. Software-selectable idle and power-down modes allow typical current consumption to be reduced to 5 mA and 50 µA respectively.

As with the 80C51, the PCB83C652 has four 8-bit quasi-bidirectional I/Os two 16-bit timer/event counters, a two-priority nested interrupt structure, full duplex UART facilities and an on-chip oscillator. It also functions as an arithmetic processor, having facilities for both binary and BCD arithmetic plus bit-handling capabilities. With a 12 MHz clock, more than half of the instructions can be executed in 1 µs; most of the remainder take 2 µs.

CIRCLE 151

A world first - Philips production of colour TV tubes passes 100 million

The world's largest manufacturer of TV picture tubes marked an important milestone in November 1987. In that month the company announced that its production of colour picture tubes had passed the 100 million mark. For a company that did not start large-scale production of colour tubes until shortly before the introduction of colour broadcasting in Europe in the mid-sixties, it is an occasion to be proud of, as Philips is the first ever company in the world to pass this production level.

The 100 000 000th picture tube was officially handed over by Mr. A. Vervoort, managing director of the Display Systems Business Group, part of the Philips Components Division, to Mr. P.J. Groenenboom, managing director of the Consumer Electronics Division of Philips, the tube manufacturer's largest customer. The ceremony took place at the Philips factory in Aachen, one of the eight international production centres.

CIRCLE 152

PHILIPS

THE COMPLETE COMPONENT COMPANY

Philips Electronic Components and Materials Division, 5600 MD Eindhoven, The Netherlands

Ranges of proven semiconductors in world's most compact plastic power package

Several ranges of Philips' high-power epitaxial and Schottky-barrier rectifiers, thyristors, GTO (gate turn-off) thyristors, darlingtons and switching transistors are now available in the plastic ISOTOP power package. This package, which is backed by both Philips and SGS-Thomson Microelectronics, offers the most optimum power rating to package volume ratio currently available. It is the only plastic power package on the market that can handle over 1000 V and carry currents of 100 A in a volume of only six cubic centimetres.

The availability of varied ranges of power semiconductors in ISOTOP brings several benefits for equipment manufacturers. Material and assembly costs are lower than for traditional metal packages such as DO-5 and, because the package can incorporate several devices, it also reduces equipment assembly costs. Furthermore, ISOTOP packages can be much more easily parallelled than traditional metal packages, facilitating use in high-current applications by attaching them to a busbar with a screw.

The ISOTOP envelope has maximum dimensions of 38.2 by 25.4 by 12.2 mm. A single ISOTOP can for example replace two DO-5, four TO-3, or four SOT-93/SOT-199 packages, depending on the current rating. The package's electrical isolation (2500 V_{RMS}) makes it ideal for mounting on a common heatsink alongside other components without the need for additional insulators.

The plastic package withstands temperatures between – 65 and + 150 °C, and has better resistance to moisture than metal packages. It has low internal mechanical stresses and generates much less radiofrequency interference than equivalent metal packages. The package is manufactured on an automated transfer-mould production line.

CIRCLE 153

Philips acquires manufacturing and marketing licence for the most powerful magnetic material in the world

As from December 1987 Philips of The Netherlands finalized a licence contract agreement with Sumitomo of Japan to manufacture and market magnets made with a new material. The newly-developed material – a combination of neodyium, iron and boron which Philips will market under the name Neodure – has the highest known permanent magnetic strength in the world, with a typical remanance of over one tesla and a maximum BH product of over 200 kJ/m^3.

Neodure magnets allow for the construction of more powerful or more compact magnetic assemblies. Typical applications include small lightweight motors (for example in cars, cordless tools and consumer products), braking systems, measuring equipment, switching, floppy disc drives. Already available in Neodure are thin-walled radial rings for DC motors – Philips is the first supplier in the world with this particular product. The new material will be available in a variety of shapes including blocks, rings, segments, discs, rods and cylinders.

Neodure is an important addition to a range of magnets which already incorporates a broad spectrum from Ferroxdure – which Philips originally invented 35 years ago – to Samarium/Cobalt-based rare earth magnets. The latter were the strongest magnets before Neodure and will continue to play an important role in high temperature applications.

Application support is directed towards exploiting the special advantages and characteristics of the new material. A dedicated R&D programme is running in cooperation with the EURAM (European Research on Advanced Materials) project to strengthen this technology for European-based firms.

CIRCLE 154

Silicon temperature sensors that measure up to 300 °C with tolerances down to 0.5 %

Philips range of KTY temperature sensors now offers the customer more choices than ever before. Choices such as tolerances right down to 0.5 %, types that can be surface mounted, types that measure temperatures as high as 300 °C, and a wider choice of centre resistance. The sensors are very stable, temperature drift being just ± 0.5 K/year, and come in plastic, glass, and glass surface-mountable encapsulations.

These silicon temperature sensors are more linear than NTC thermistors, and cover a temperature range between three or more times as great without needing linearization circuits. The sensors can be incorporated into electronic thermostats and thermometers, temperature compensation circuits, and battery chargers. They are suitable for applications ranging from simple domestic temperature adjustment to the most advanced industrial microprocessor-based control systems.

The basic type in the range is the KTY81, which comes in a plastic SOD-70 encapsulation. The KTY83 is similar, but in a SOD-68 (DO-34) glass encapsulation. A special SOD-68 envelope provides the KTY84 with a temperature range of between 0 and 300 °C, and in contrast to NTC thermistors, without the need for linearisation circuits. The KTY85 comes in a MELF glass encapsulation (SOD-80) for surface mounting.

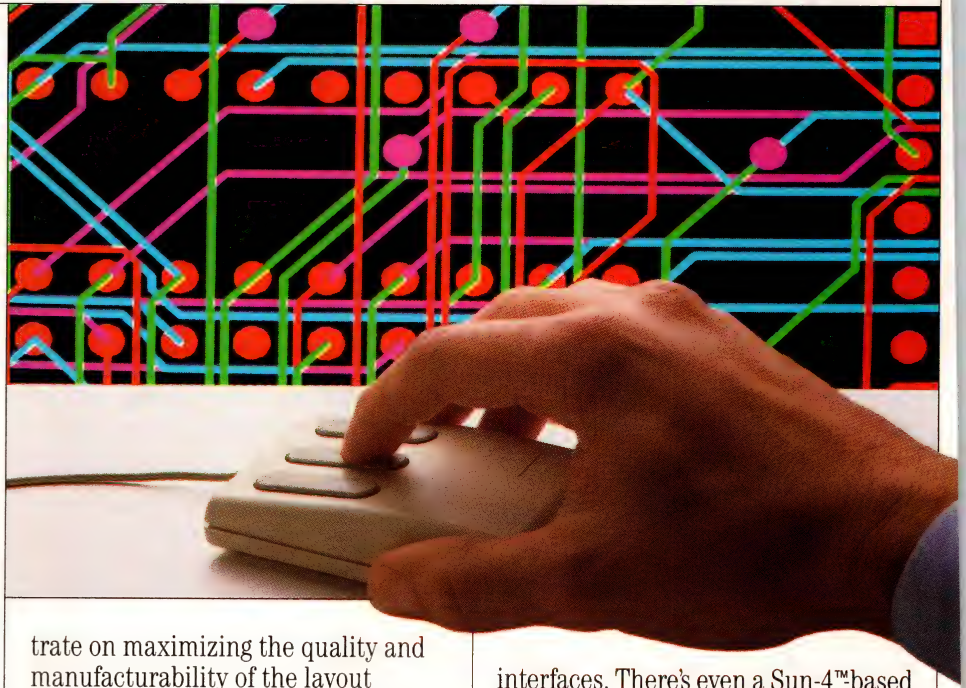
All of these sensors have tolerances between 1 % and 5 % (depending on type). A further device, the twin-sensor KTY86, combines a matched pair of sensors to reduce the tolerance to a very low 0.5 %. This sensor is ideal for precision thermometers; it comes in a VO-69 encapsulation, with a body 5.8 mm long and 3.5 mm in diameter, and with 15 mm long leads.

The sensors are available with a choice of centre resistance values within the bands 975 to 1025 Ω and 1950 to 2050 Ω. The response times can be as fast as 1 s.

CIRCLE 155

PHILIPS

NOW YOUR RIGHT HAND CAN KNOW WHAT YOUR LEFT IS DOING.



Ever seem like your CAE and CAD people are playing for different teams? Chances are it's because your design systems can't communicate critical information from the engineer to the layout designer. So instead of a smooth handoff, you get hand-to-hand combat.

But now, there's a system that streamlines the way CAE and CAD teams work together.

It's Daisy's BOARDMASTER.™ The first automated system that plays by the rules of real world system design.

With its rules-driven PCB design environment, BOARDMASTER gives engineers the flexibility to specify key design rules in the schematic. Rules for signal priority. Ordering and termination for ECL nets. Package types and power definition. Pre-packaging and pre-placement priorities. Pin and gate swapping. And many other important design considerations.

This critical information becomes part of the design database. And is passed directly to BOARDMASTER's powerful set of PCB layout tools.

With these rules guiding the process, layout designers can concentrate on maximizing the quality and manufacturability of the layout without having to second-guess the engineer's real intentions.

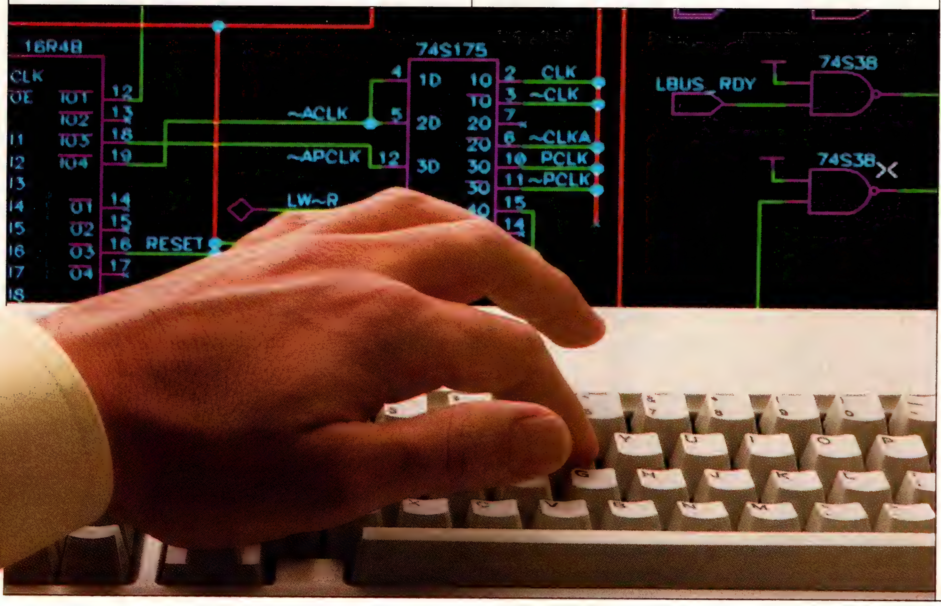
BOARDMASTER comes with the most advanced set of layout tools available anywhere. Like 100% autorouting. Full support for SMD, ECL, analog and ultra fine line designs. Plus a variety of manufacturing interfaces. There's even a Sun-4™-based routing accelerator to make short work of your most complex layouts.

BOARDMASTER even takes the frustration out of design changes. Because it updates only the parts of the database that need updating. Which keeps ECO from becoming a four-letter word.

So if you'd like to get a grip on better board design, put BOARDMASTER to the test in your next project. And give your entire team a hand.

For a demonstration or more information, call Daisy at:
1 (800) 556-1234, Ext. 32.
In California: 1 (800) 441-2345, Ext. 32.

European Headquarters:
Paris, France (1) 45 37 00 12.
Regional Offices:
England (256) 464061;
West Germany (89) 92-69060;
Italy (39) 637251.



daisy SYSTEMS CORP.

© 1988, Daisy Systems Corporation. BOARDMASTER is a trademark of Daisy Systems Corporation. Sun-4 is a trademark of Sun Microsystems, Inc.

Silicon compilers tame 10,000-gate-plus ASICs, gate arrays

Traditional design methods that manipulate gates or simple macrocells become unwieldy at densities of tens of thousands of gates per chip. However, silicon compilation offers a new paradigm for the management of these large, complex designs.

William J Stenzel, *Tandem Computers Inc*

Silicon compilation is an alternative to gate arrays and standard cells for implementing ICs. A silicon compiler creates layouts of part or all of a chip from a high-level description. Therefore, when using a silicon compiler, you can focus your efforts on high-level verification and system-timing issues rather than on low-level circuits and gates. Conceived for custom chips, silicon-compilation techniques also prove useful for gate arrays containing more than 30,000 gates.

Unlike gate-array or standard-cell designs, which require a gate-by-gate approach, silicon compilers allow you to manipulate high-level functions. You'll find silicon compilers' advantages most evident when you design data-path blocks and specify compiler functions in terms of latches, register files, multiplexers, arithmetic and logic units (ALUs), and shifters as well as in terms of their connections to data buses. In contrast, when using standard cells or gate arrays, you build up high-level functions from a library of low-level elements, such as gates and flip-flops, and then route signals between them.

Compiled chips, like standard-cell chips, require full wafer processing, in contrast to gate arrays, which require only the personalization of an existing base wafer's metalization. Consequently, nonrecurring expense (NRE) and time required to fabricate prototypes of a compiled chip are similar to those of standard-cell chips and higher than for small gate arrays.

Silicon compilation excels at highly structured, regular functions, such as data paths and memories. Such functions appear, for example, in digital signal processors, which are primarily structured blocks with most of their interconnections going to the external pins. Further, more complex chips may have islands of regularity in a sea of interconnection.

Look at your application to decide if your design is large enough to benefit from compilation. To consolidate only a few thousand gates of random logic, you might find a gate array more cost-effective. Designs in excess of 10,000 gates are the best candidates for compilation.

Compiler vendors offer two types of tools

When evaluating silicon-compiler vendors, you will find that some offer generic tools while others offer tools specific to their own foundries. Two that offer generic tools are Compiler Systems Corp (San Jose, CA) and Seattle Silicon Corp (Bellevue, WA). You may compile your design for fabrication at one of several

Silicon compilers allow you to manipulate high-level functions; you needn't work at the gate level.

foundries these two companies' compilers support. In contrast, VLSI Technology Inc (San Jose, CA) offers compilation tools customized to VLSI Technology's fabrication process.

Other differences among compiler vendors lie in the features their compilers offer. Compilers from Silicon Compiler Systems and VLSI Technology are complete packages, including data entry, simulation, and timing analysis. Seattle Silicon's offering requires a third-party CAE workstation and software to provide many functions, such as schematic capture and logic simulation. Finally, Silicon Compiler Systems and Seattle Silicon offer tools that let sophisticated customers such as semiconductor houses create their own block compilers. This feature enables such customers to add proprietary functions or to tune functions to their own processes.

Changing your mindset

When first using a silicon compiler, you might need to make some changes to your design approach, particularly if your experience is with board-level TTL. Estimating whether or not a given design will fit onto a chip requires a set of guidelines that differ from those for pc-board layout. For example, when you size the pc-board area for a TTL design, half a dozen inverters and a 64k-byte RAM take about the same amount of space. Conversely, area within compiled chips depends more on the amount of logic in a function. Moreover, interconnections within a chip consume considerable space, occupying as much area as active logic in many cases.

Circuitry details, too, might dictate some changes in your design methods when you first use a silicon compiler. For example, although most systems use an edge-triggered register methodology that's familiar to TTL designers, Silicon Compiler Systems' Genesil differs in that it supports a latch-based scheme with 2-phase, nonoverlapped clocks and precharged buses, more typical of custom IC designs.

In contrast to edge-triggered schemes, which use registers as state elements that sample inputs at a clock edge (and which allow data an entire clock period to propagate through the subsequent logic before being sampled at the next clock edge), 2-phase latch-based schemes use transparent latches as state elements. The latches propagate data from their inputs to their outputs when the clock that enables them is asserted, and they hold their data when the clock is not asserted.

In the 2-phase scheme, a clock generator converts a master clock into two phases: phase A and phase B. Phase A is asserted when the master clock is high; phase B, when the master clock is low. These two phases are interlocked so that they are never simultaneously asserted (hence the term "2-phase nonoverlapped").

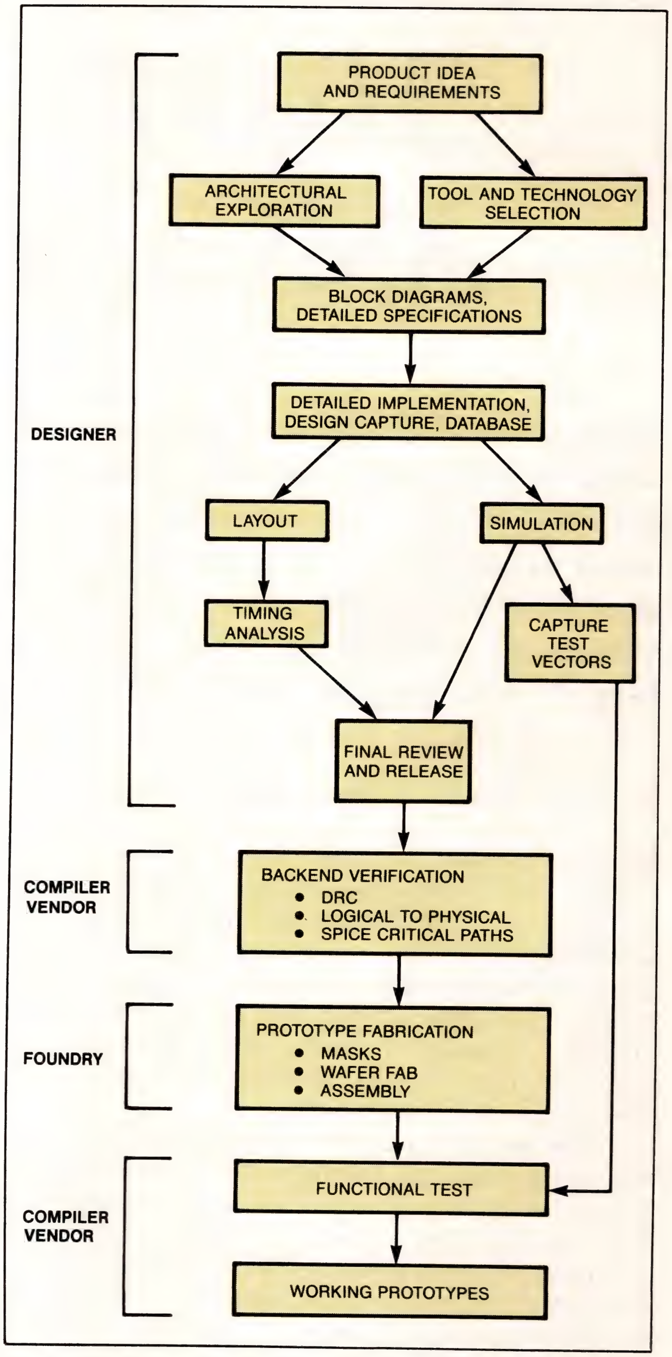


***Fig 1—The designer, the compiler vendor,** and the silicon foundry must all cooperate to bring an IC from an idea to a working chip.*

You must alternate which phase controls the latches throughout your design: Signals originating in a latch controlled by phase A must terminate in a latch controlled by phase B. When a phase A latch is propagating, the subsequent phase B latch is holding, and vice versa, thus eliminating race conditions. Transparent latches require roughly half the space and internal logic as edge-triggered registers. Hence, they provide an advantage in chip size. After becoming familiar with the technique, you will find the latch-based scheme to be flexible and useful for pushing the performance of critical timing paths.

Design process

Fig 1 charts the steps—covering several design disciplines—that you must take to transform your product idea into a working chip. You must organize major projects with an awareness of these disciplines. During the specification and initial design phase, several engineers might each concentrate on a functional area of the design. As the project progresses, each engineer might focus on simulation, layout, or timing analysis.

In the architectural-definition phase, you must determine how to map your idea onto chips and evaluate design alternatives against system cost and performance requirements. Using the compiler, you can create trial designs of major blocks for evaluation. Because you describe blocks by their functional attributes, the compiler can capture the rough design and do the detail work necessary to determine size and speed estimates.

For example, within a data path, you could specify interconnections between ALUs, latches, register files, and multiplexers via major buses (as you would when drawing a conceptual block diagram). You can sketch the design alternatives and have the compiler expand the sketch into full detail to facilitate experimental designs for architectural evaluation. By the end of this phase, you will produce block diagrams and detailed specifications for the design.

Cost estimates

The major variables in a chip's cost are its size, package, and foundry. You can estimate size by experimenting with designs on the compiler and incorporating major logic blocks, signal buses, and an allowance for details not included in the rough design. High pin counts can create pad-limited chips in which I/O pads on the periphery determine the die size. As the die size increases, chip cost dramatically increases. Your foundry should help by estimating the cost based on die size.

Pin-count estimates should include power and ground pins. To reduce noise from simultaneously switched outputs, you need at least one power and ground pin for every eight to ten simultaneous outputs. The required ratio varies with the speed of the output drivers and the fabrication process. As pin counts increase, package costs also increase. Ceramic pin-grid-array (PGA) packages of 100 to 180 pins are available, but they can add $10 to $20 to parts cost.

Design capture

To implement your design, the compiler must capture several layers of information. Working from the inside of the chip to the outside, you should follow these steps in the design capture:

- Define the functional blocks and specify block interconnections.
- Specify chip I/O pads for function and location on the chip periphery.
- Connect the pads to the internal circuitry.
- Specify the package type and the bonding between chip I/O pads and package pins.

At the block-specification phase, you begin by selecting the desired type of functional block from a block-creation menu. The detailed specification varies with the type of block. For example, a random-logic block would comprise simple gates. Seattle Silicon and Silicon Compiler Systems support a schematic-capture mode using third-party CAE workstations. In this mode, you could specify the random-logic block by interactively drawing a schematic of the gates and identifying the external ports. Alternatively, Silicon Compiler Systems also supports a menu-driven, text-oriented means of specifying random-logic blocks.

A RAM or FIFO block, on the other hand, requires different information. The meaningful parameters for these blocks are size, organization, and timing. You may specify these parameters in a menu-driven fashion by filling in the appropriate blanks for the number of inputs, the number of words, the speed options, whether the block is to be single or multiple ported, and whether or not the output is latched.

Such blocks as read-only memory (ROM) or programmable-logic arrays (PLA) need this type of menu-driven structural information; in addition, they require programming information to specify their contents. For example, Genesil accepts truth tables, fuse maps, logic equations, or state-machine descriptions as formats for conveying PLA contents. Logic minimizers, such as Espresso from the University of California at Berkeley, *Silicon compilation excels at implementing highly structured, regular functions, such as data paths and memories.*

are available for PLA minterm reduction on several compilers.

You also have options in the method of specifying ROM contents. Genesil includes a macro assembler that can create symbolic macros and generate ROM contents by macro assembly. Alternatively, you can use a file containing the object code as ASCII ones and zeros. (At Tandem, designers develop microcode on a system other than the compiler and then port the finished object code to the compiler, formatting it appropriately along the way.)

Consider also complex blocks such as data paths. Genesil uses a menu-driven approach to specify data-path elements, bus connections, and orientation. Under Genesil, the entire data path is the same bit width (that is, number of bits in a word slice), although some elements allow masking of selected bits. (Although this scheme might sound restrictive, it's actually quite versatile.)

After you create the functional blocks, you must interconnect them. Genesil uses a textual net list to connect the external ports on each functional block to a named net. Seattle Silicon uses a third-party CAE-workstation schematic package to interconnect blocks.

Careful planning and good naming conventions are important to the interconnection phase. If several engineers work on different portions of a complex chip, prior agreement on net names and spellings will allow smooth and accurate net listing. Make the port names the same as the net names whenever possible.

Chip layout

The first step in chip layout is compiling the functional blocks, transforming them from a text description into a custom layout. After compilation, you can manipulate them as blocks having signal ports on their edges, without dealing with their internal layout. The rest of the layout phase consists of placing the blocks and routing their interconnections.

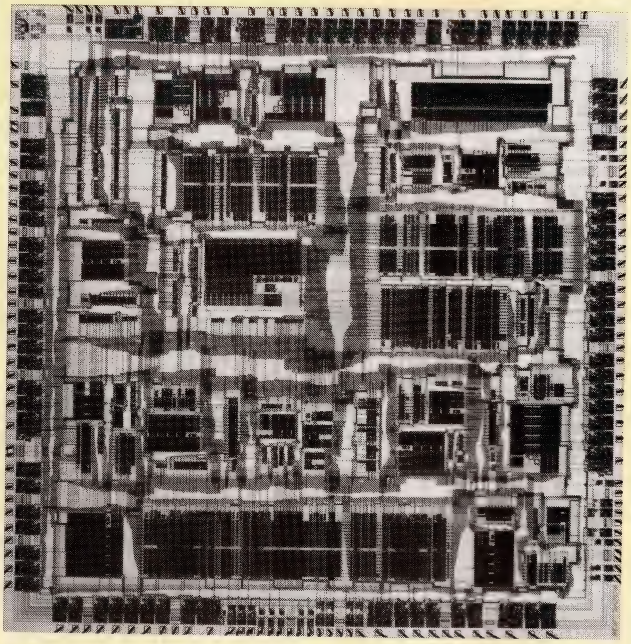
Compilers rely on an automatic signal router for interconnection. Because a chip's size is flexible at this stage, the router can push blocks away from each other to make room for the interconnections, guaranteeing that all the interconnections can be made. However, the result can be a very large chip. Designers exert the most influence on the layout through their placement of the blocks. Other factors affecting layout include the relative priority of signals and, on some compilers, assignment of routing channels.

You should have a layout plan in mind for the overall interconnection of the blocks (such as where major buses tie to which blocks). Although compilers have placement aids or even auto-placement algorithms available, your insight is important in producing a tight layout of a complex chip. Experimenting with alternate layouts will be fruitful, both for trying significantly different placements and for fine tuning the most promising placement. Achieving a good layout is very much an iterative process.

Background

Silicon compilers began generating interest in 1983 and 1984 (**Refs 1, 2, and 3**), and they have since evolved into practical tools, yielding such products as graphics controller chips (**Ref 4**).

The information in this article is based on the experience of designers at Tandem Computers, who used silicon compilation to realize four CMOS chips employed in the company's NonStop CLX, a user-serviceable distributed on-line transaction-processing (OLTP) system. One of the chips—the CPU—measures approximately 500×500 mils and contains 60,000 transistors.



***Tandem Computers Inc produced this CPU chip** with a silicon compiler for its NonStop CLX fault-tolerant computer. Part of a four-chip set, the CPU measures 500×500 mils and contains over 60,000 transistors.*

The compiler should assure adequate power and clock distribution. For example, Genesil calculates the power of each block and uses a power/ground bus width based on the total power of all blocks downstream from a given point. This procedure results in power buses that begin with a width of the power bonding pad and taper progressively. Clock lines may benefit from high-priority routing and several-times wider-than-minimal metal lines. In some cases, the clock lines can be isolated from other signals by surrounding them with ground lines.

Because interconnection delays stemming from wiring capacitance can be significant in CMOS, you must monitor the chip's critical paths while optimizing the chip size.

Simulation—verifying your design

Verifying your design through simulation is essential to maintaining the project schedule and budget. The expense, effort, and time required for chip iterations make a first-pass success highly desirable. Good simulation tools and a careful strategy make first-pass success attainable. The compiler generates a simulation model for your design automatically, ensuring that what you simulate corresponds to what you implemented.

Table 1 describes several levels at which to simulate. As you enter your design, you may interactively simulate small portions. For example, you may perform a check on a piece of control logic by manually applying a few patterns and observing the response. This level does not provide comprehensive verification, but it's a good indication that you're on the right track.

TABLE 1—LEVELS OF SIMULATION

TYPE	CHARACTERISTICS/USE
INTERACTIVE	• GOOD FOR INITIAL DESIGN CHECKOUT OR TROUBLE SHOOTING. • POOR FOR COMPREHENSIVE VERIFICATION. • POOR REPRODUCIBILITY.
HAND-CODED VECTOR	• ALLOWS SIMULATOR TO CHECK EXPECTED RESULTS. CAN BE RERUN AFTER CHANGES AS A REGRESSION TEST. • CAN BE USED AS PART OF PRODUCTION TEST. • RELIES ON DESIGNER INGENUITY TO COVER ALL TEST CASES. CAN OVERLOOK SYSTEM-LEVEL PROBLEMS.
SYSTEM-LEVEL	• EXERCISES CHIP IN SYSTEM ENVIRONMENT. • GIVES HIGHEST DEGREE ON CONFIDENCE. • CONVERGES MICROCODE/SOFTWARE AND HARDWARE VERIFICATION. • CAN EXTRACT RESPONSES FOR PRODUCTION TEST.

At the next level, you can apply hand-coded simulation vectors to the whole chip or to large parts of it. These vectors can become production-test vectors. This level is more rigorous and is reproducible as a regression test. However, it still relies on your ingenuity to specify the stimulus and response. Because simulation runs can require hundreds or thousands of vectors, the simulator must check for the expected response to a given stimulus and automatically flag any discrepancies. This rigorous simulation is far superior to the alternative of visually checking a printout of the simulator's output for erroneous responses.

Finally, you can embed the chip into a model of its intended application and perform system-level simulations. This level can expose subtle bugs and boundary conditions that you would not normally find in your lab.

Timing analysis

Accurate prediction of the performance of your chips is an important part of the design. You need to relate your system's goals and constraints and identify the areas of your chip that need fine tuning.

Two main components of CMOS circuit delays are the gate propagation delay and the additional delay arising from the capacitance and resistance of the interconnection. To obtain accurate timing numbers, you need to incorporate the interconnection loading derived from the actual layout of the chip. In a large chip, the interconnection delay of a signal crossing the chip can exceed a gate's nominal propagation delay. An excessive interconnection delay indicates a very long routing or a net with a large fan-out. You can shorten the delay by increasing the strength of the driver, altering the placement of the chip to shorten the interconnection length, or revising the logic to reduce the fan-out.

Two classes of timing-prediction tools exist. The more traditional tool is based on circuit simulation. Using a model of your circuit, you can stimulate it to trace specific circuit paths to obtain their delay. In general, the more accurate the calculations, the slower the simulator. Spice, a commercially available circuit simulator, is an example of a very accurate and computation-intensive tool. One of the main drawbacks of this type of tool is that it gives you information about only the paths you specify and already suspect—not unexpectedly slow paths.

The second class of timing tool, static analysis, can examine all paths and tell you which are the longest.

Two types of compiler vendors exist: those offering generic tools and those offering tools specific to their own foundries.

Static timing analyzers first characterize the delay from input transitions at each gate to the output transition at the gate's loads. They then trace the paths through the circuit, adding up the delays as they go. The most powerful form of analysis traces paths from their origin in a clocked element to their termination in a clocked element. In a synchronous system, this analysis identifies the critical paths limiting clock speed.

The static-analysis tool's obvious benefit is that it tells you about timing paths you may not have realized were slow. Other capabilities of a sophisticated static tool include incorporating external setup and hold requirements, checking margins on internal hold times, and the ability to specify timing paths to be ignored. Genesil also has the ability to automatically extract a Spice model of a specified path to allow more exact timing simulation where desired. The accuracy of a static timing analyzer depends on the sophistication of its models of transistor characteristics and resistive and capacitive loading. Static timing analyzers better suit synchronous circuits than asynchronous ones.

You can use both timing tools to observe the effects of temperature, variations in voltage, and variations in the fabrication process.

The next step is to assure that the physical mask that the compiler produced accurately represents your design. To accomplish this task, compiler vendors provide various types of post-design checks. The most basic is the traditional design-rule check (DRC). The DRC program processes the mask's data against the physical design rules for the foundry you have selected, checking that trace width and spacing meet a minimum specified size and that the transistors are properly formed, for instance. This checking assures that the chip can be fabricated.

Checking the mask

You can make an additional check by programmatically extracting the circuit's topology (that is, by deriving the circuit elements and the net list that they implement from the mask). This extraction can further verify the physical design, either by direct comparison to the logic design you previously simulated or by simulation against the same stimulus/response vectors you previously used.

You may wonder why compilers need this type of post-verification; after all, they should automatically generate correct silicon. However, one of the benefits of a silicon compiler is that it facilitates large, complex chip designs, such as microprocessors. Designers demand rich sets of design elements, and vendors enhance their products for higher density and performance. The result is that as designers push beyond what has been done before, a possibility of generating bugs exists. Even a single error in a chip can cause a malfunction; therefore, post-verification is essential to ensuring correct silicon.

TABLE 2—PROTOTYPE FABRICATION STEPS

TASK	TIME	COST
FINAL VERIFICATION	2 TO 4 WEEKS	SEE NOTE
DATABASE CONVERSION	1 WEEK	$2k TO 10k
PLOT APPROVAL	2 DAYS	—
MASK GENERATION	1 TO 2 WEEKS	$30k TO 40k
WAFER FABRICATION	6 TO 10 WEEKS	$1k TO 20k
ASSEMBLY	1 TO 2 WEEKS	—
PACKAGE PART TEST	1 TO 2 WEEKS	SEE NOTE

NOTE: PART OF BROKERAGE PACKAGE FROM COMPILER VENDOR.

After verification, build prototypes

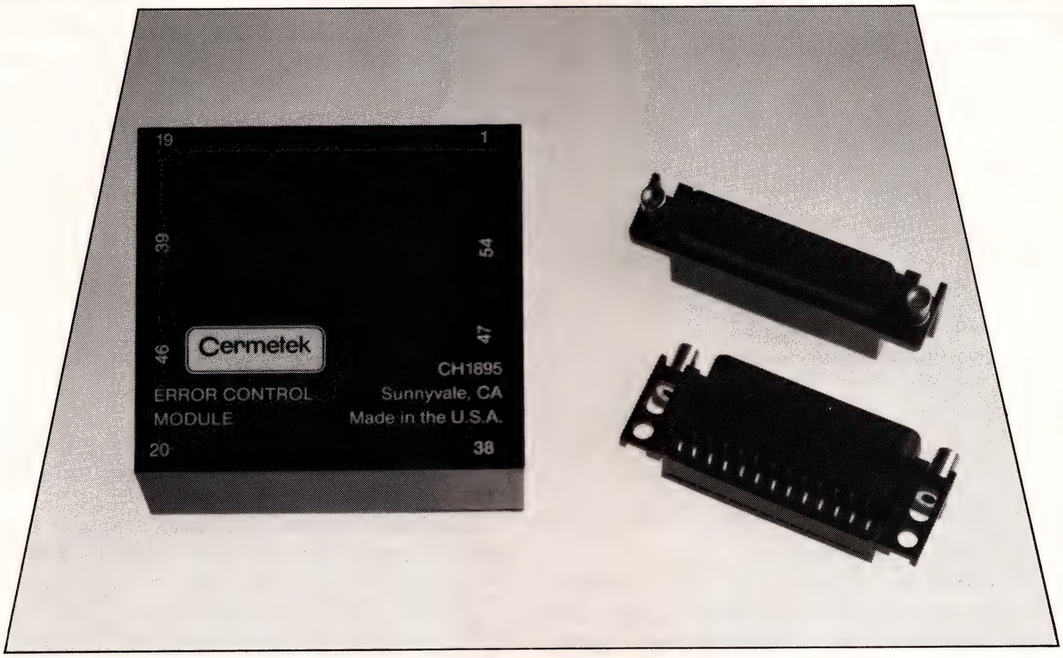
When your chip has completed final verification, you are ready to build prototypes. Several compiler vendors offer a brokerage service, for which they coordinate initial fabrication with the foundry and deliver the working parts to you. Seattle Silicon and Silicon Compiler Systems offer this service with guarantees of working parts.

To ensure a smooth path for your prototypes and to prepare for production, you need to begin a business relationship with your foundry well in advance of first silicon. This preparation can insure that the right resources and materials are in place when you need them. For example, if you specify a package type that the foundry does not stock, the lead time to procure it can be longer than the fabrication time.

Advance discussions can also clarify the time and charges for fabrication. The overall time and charges for getting tested parts are substantially more than for simply running a wafer lot. You need to make certain that you understand the steps in the process **(Table 2)**. For example, starting from a database tape, the foundry converts database formats for the mask vendor and has the masks fabricated, inspected, and repaired before processing. After processing, the parts are assembled. You also need to allow time for testing, either at the foundry or at the compiler vendor. **Table 2** de-

FOR SALE
ERROR PROOF DATA

X.25 LAPB AND/OR MNP LEVEL 4



Ever worry about transferring bad data on a block transfer? Bad data can be prevented by the use of industry standard error correcting protocols. Our CH1890 series of backward error correcting components insure absolutely reliable data transfer. A bad bit cannot get through the link. Cermetek's error correcting components can be incorporated in a host of communication products with speeds up to 19.2K bps supported.

Easy to design in

Cermetek has eliminated the guesswork in deciding which error correcting protocol to choose when designing your product. This is accomplished by offering two popular methods of error correcting, X.25 LAPB and MNP Level 4, in one component. Now there is a single source for all your error correcting needs. Both methods are available individually also.

Each error control component provides two separate RS-232 ports, a data pass through mode and individual component control by hardware straps or extended AT commands.

The CH1890 series provide error free data transfers and also application flexibility for CAD/CAM graphics, asynchronous dial-up, file transfers and backward error correcting for high speed modems such as V.32.

The CH1890 series are low profile, low power and low cost. Write or call today for more information.

1890 SERIES ERROR CORRECTING COMPONENTS

FEATURES	CH1895	CH1891	CH1890
Speed: 300 - 19.2K bps	X	X	X
MNP Level 1-4	X		X
X.25 LAPB	X	X	
Session Transfer Full Duplex	X	X	X
AT Commands	X	X	X
Pass Through Mode	X	X	X
In band/Out band flow control	X	X	X
Low Power 5V Operation	X	X	X
Low Profile (2.2" L x 2.4" W x 0.5" H)	X	X	X

Cermetek
microelectronics

Cermetek Microelectronics, Inc.
1308 Borregas Avenue Sunnyvale, CA 94088
Telephone: 408/752-5000
Fax: 408/752-5004
Twx: 910-379-6931

MNP is registered trademark of Microcom Corp.

CIRCLE NO 140

You may need to make some changes to your design approach, particularly if your experience is with board-level TTL.

TABLE 3—CHARACTERIZATION AND PRODUCTION TESTS

TYPE OF TEST	AREAS TESTED
FUNCTIONAL	• OVERALL LOGICAL INTEGRITY OF CHIP.
DC PARAMETRIC	• VOLTAGE THRESHOLD OF INPUT PINS. • VOLTAGE AND CURRENT OF OUTPUT PINS. • LEAKAGE CURRENT OF INPUT AND 3-STATE PINS.
AC—SETUP/HOLD	• CHIP INPUT SETUP/HOLD FROM EXTERNAL CLOCK
—OUTPUT DELAY	• DELAY FROM CLOCK OR INPUT PINS TO OUTPUT PINS.
—CYCLE TYPE	• MAXIMUM OPERATING FREQUENCY FOR CLOCK.

scribes the steps in prototype fabrication, including the time and cost required.

If you use a brokerage arrangement, the foundry delivers untested parts to your compiler vendor. The compiler vendor then tests the packaged parts using test vectors from your simulation runs. This test assures functional parts and provides some speed testing. The compiler vendor's involvement usually ends here.

You must still do substantial test development to put your parts into production. Production tests have three broad components: functional tests, dc tests, and ac tests (**Table 3**).

Functional tests find fabrication faults quickly. The vectors used for simulation during design verification may not be appropriate for production. Verification typically assumes that the logic elements are perfect and checks to determine if your design functions as intended. These tests can have poor fault coverage or can be excessive in length. One current weakness of silicon compilers is poor support for fault-grading tools with which you improve production tests.

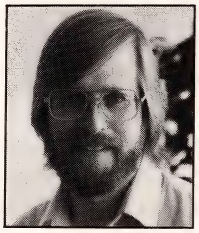
Compilers support transporting simulation vectors to selected IC testers. (With Genesil, Tandem designers needed to develop a format converter for Sentry Schlumberger Inc and Ando Corp for production. Once this tool was in place, they captured vectors from system-level simulations and incorporated them into production tests. This tool proved to be very effective: The chips could be tested with the same stimuli that they would ultimately encounter in the system.)

Dc and ac tests check the chip against its data-sheet specifications. The dc tests include input-voltage thresholds, output voltage levels at specified currents, and input and 3-state leakage currents. Ac tests include output delays, cycle times, and setup and hold times. Ideally, you should characterize these parameters over a range of supply voltages and temperatures corresponding to the specified operating range. Use a sampling of parts over different fabrication runs to include process variations. This testing lets you balance your system requirements against the actual performance of the chips and establish test limits to maximize your yield. It can also indicate problem areas requiring further attention. Your foundry can help in performing this characterization. **EDN**

References

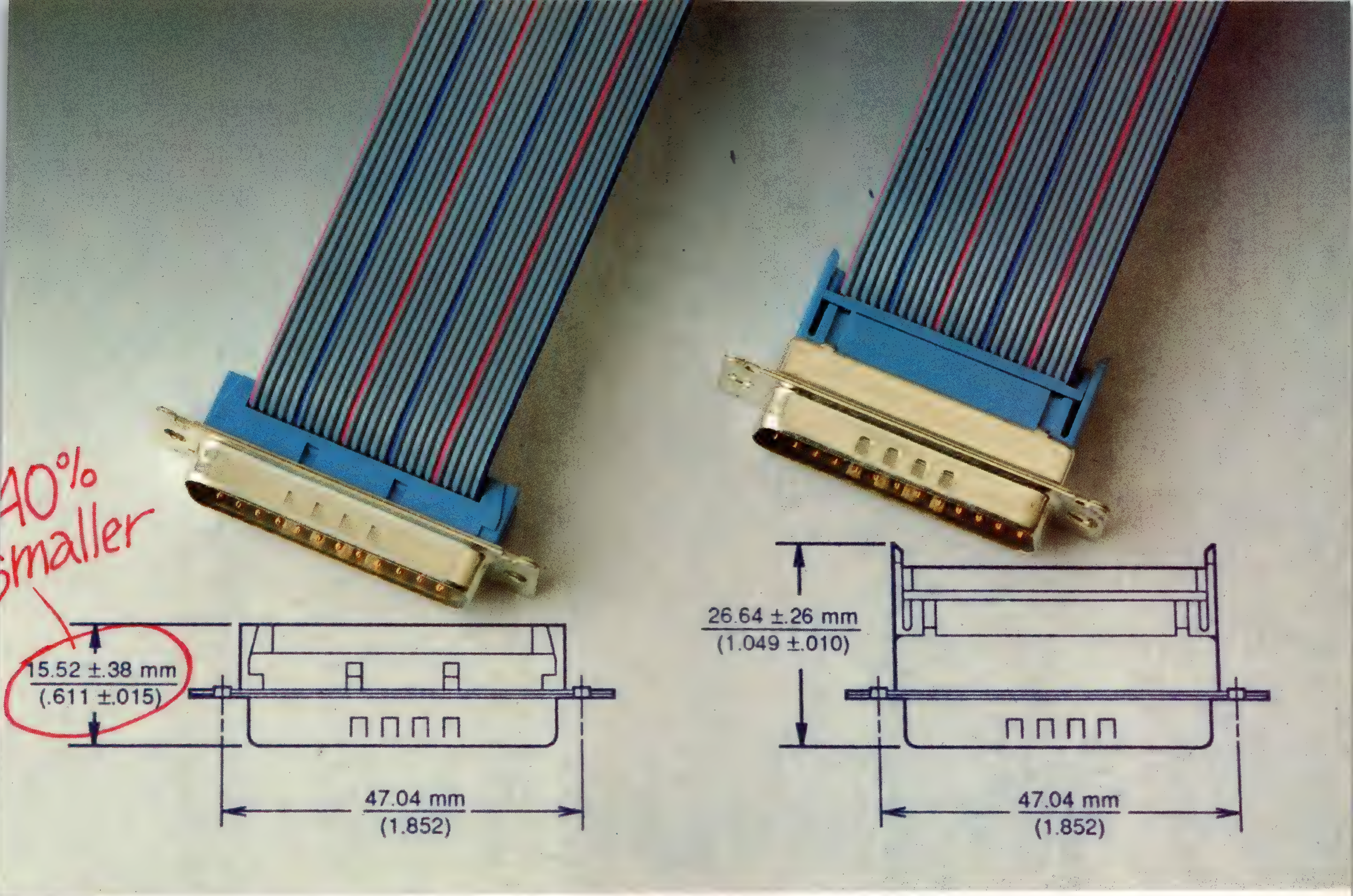
1. Johnson, Stephen C, "VLSI Circuit Design Reaches the Level of Architectural Description," *Electronics*, May 3, 1984, pgs 121-128.
2. Johnson, Stephen C, "Silicon Compiler Lets System Makers Design Their Own VLSI Chips," *Electronic Design*, October 4, 1984, pgs 168-181.
3. Wallich, Paul, "On the Horizon: Fast Chips Quickly," *IEEE Spectrum*, March 1984, pgs 28-34.
4. Jones, Michael, and Bailey, Michael, "High Performance Graphics Via Silicon Compilation," *VLSI Systems Design*, March 1987, pgs 32-38.
5. "LSI Logic's Big Bag of ASIC Design Tools," *Electronics*, February 5, 1987, pgs 59-61.
6. "A Compiler for Semicustom Solutions," *Electronics*, February 5, 1987, pgs 62-64.

Author's biography



William Stenzel is a development engineering manager for Tandem Computers Inc (Cupertino, CA) and has been with the company for seven years. He is currently responsible for processor and memory development for distributed systems. Prior to Tandem, he spent five years with Hewlett-Packard, where his responsibilities included management of a custom CMOS processor project. He received his BS in Computer Engineering and MS in Computer Science from the University of Illinois.

Article Interest Quotient (Circle One)
High 491 Medium 492 Low 493



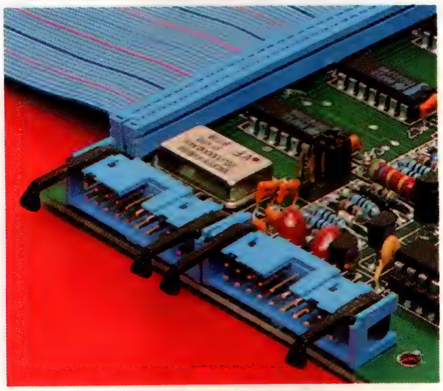
WHEN SPACE-SAVINGS IS CRITICAL, WE MAKE SMALLER, SMARTER.

Our new connectors match their bigger brothers in performance and reliability. There's one big difference — they save you space... a lot of space. Compact, convenient, cost-effective, these space savers offer improved system flexibility and superb electrical integrity and strength. And, lots of new space saving possibilities.

The Ansley® Metal Shell Low Profile "D" connector, for example, does exactly what the full-sized "D" connectors do, but in about half the space — .602″ male, .612″ female and .990″ matched pair. Low Profile "D" connectors are compatible with all standard "D" connectors. They're available with plated and unplated backshells for both flat or round cable. Strain reliefs and mounting hardware accessories are also available.

Ansley® Slimline Connectors

The new Slimline PCB Solder Transition Connectors provide extra fast flat cable soldering to printed circuit boards.



Slimline PCB Connector, Vertical Ejector Headers

Choose from 16 contact sizes and a variety of solder tail lengths, our Slimline design helps you to maximize your packaging density.

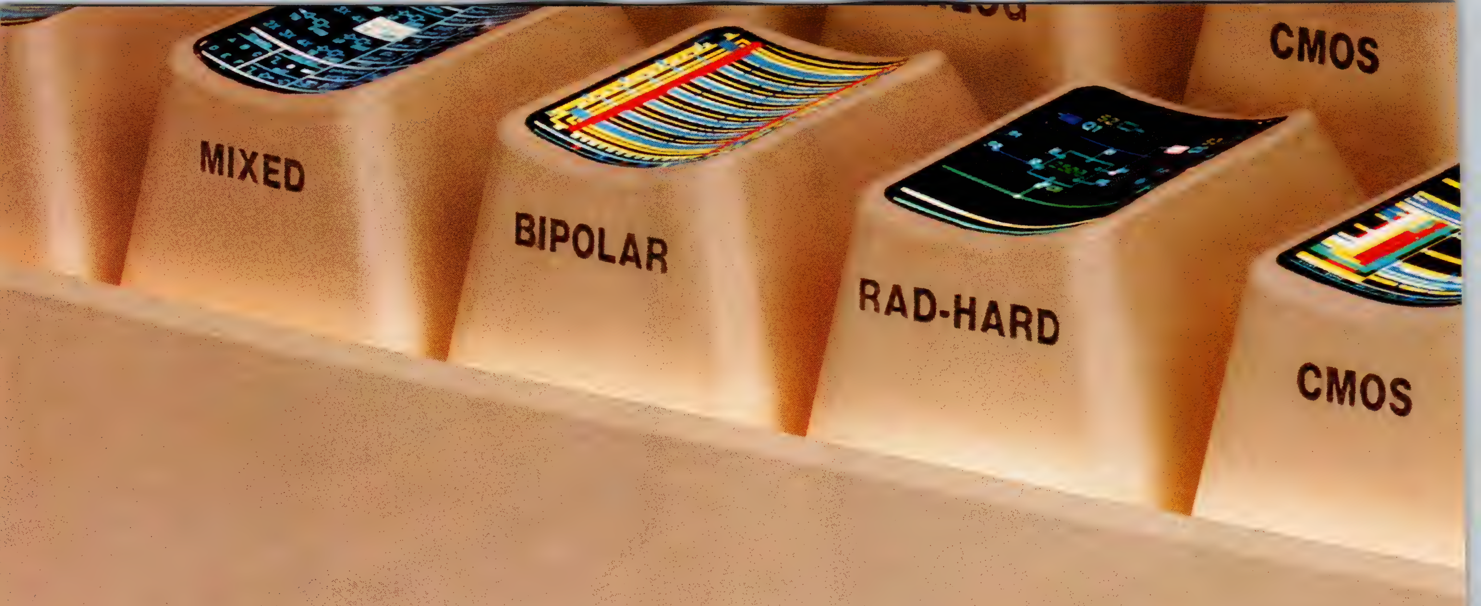
Ansley® Low Profile Vertical Ejector Headers

These new headers provide the stability and convenience you need whenever repeated connection and disconnections are required. *Unlike conventional designs where the ejector latches swing left and right, the Low Profile Vertical Ejector latches swing front and back, permitting you to make maximum use of your PCB space.*

These new connectors are just one *small* accomplishment from Thomas & Betts. So, when your space is at a premium, think smart... think Thomas & Betts. *For complete detailed information,* write or call Thomas & Betts Corporation, 1001 Frontier Road, Bridgewater, NJ 08807, (201) 685-1600.

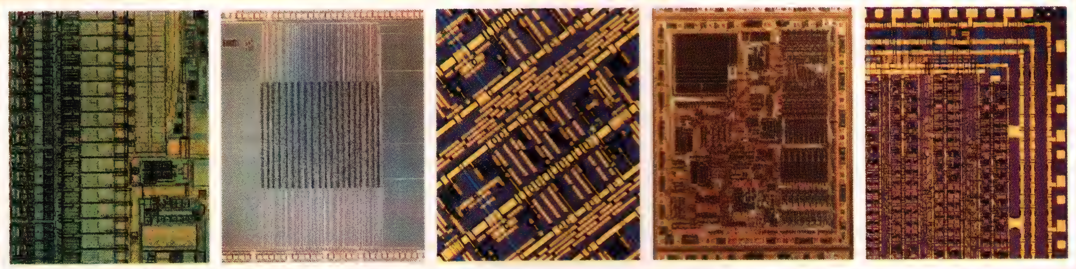
Thomas&Betts

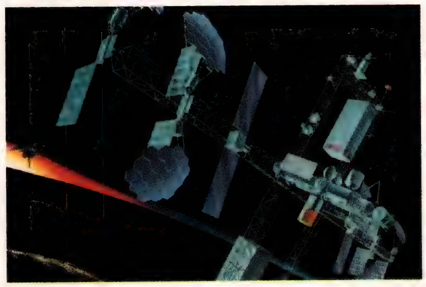
CIRCLE NO 146



Here are the keys to faster design of military ASICs...

"All my military and space ASICs...same tools!"
"Same supplier, too... Harris."





One workstation, one company, for all your military/space designs.

Remember when semicustom IC designing was impractical because your technology options were too limited, your CAD tools too new and turnaround too slow?

Times have changed! Now Harris makes designing military/space ASICs — in the broadest range of technologies — easier than ever. Because you use the same workstation and design tools for all.

Libraries of solutions: Our GaAs DIGI-II library offers nearly 50 fully characterized cells that are ECL, TTL, CMOS or GaAs compatible. Or...in silicon our advanced HSC 2.0-micron rad-hard CMOS library provides cells and macros you can intermix. Resident libraries also exist for CMOS and bipolar, analog, and digital plus analog/digital mixed technologies.

Hardware and software: Our open-system software CAE/CAD toolset fully integrates with Harris/Masscomp workstations, and meshes easily with other UNIX-based platforms. Daisy and Mentor support is also available.

On to manufacturing: You handle the front-end; leave the back-end to Harris. We carry your ASIC design through to mask, then manufacturing — with the screenings you want and most popular packages: metal flat-pack, side-brazed DIP, chip carriers, and more.

Guaranteed survivors: Now you can create ASICs that tap the high speed of GaAs, or the low power of CMOS, and are guaranteed to survive military and space environments. And you can do it faster.

For more on military/space silicon and GaAs ASICs, send for our Rad-Hard/Hi-Rel Data Book. Contact Harris Systems Ltd., Semiconductor Sector, Eskdale Road, Winnersh, Wokingham, Berks, RG11 5TR, England. Phone 0734-698787.

IN MILITARY ASICs, THE NAME IS

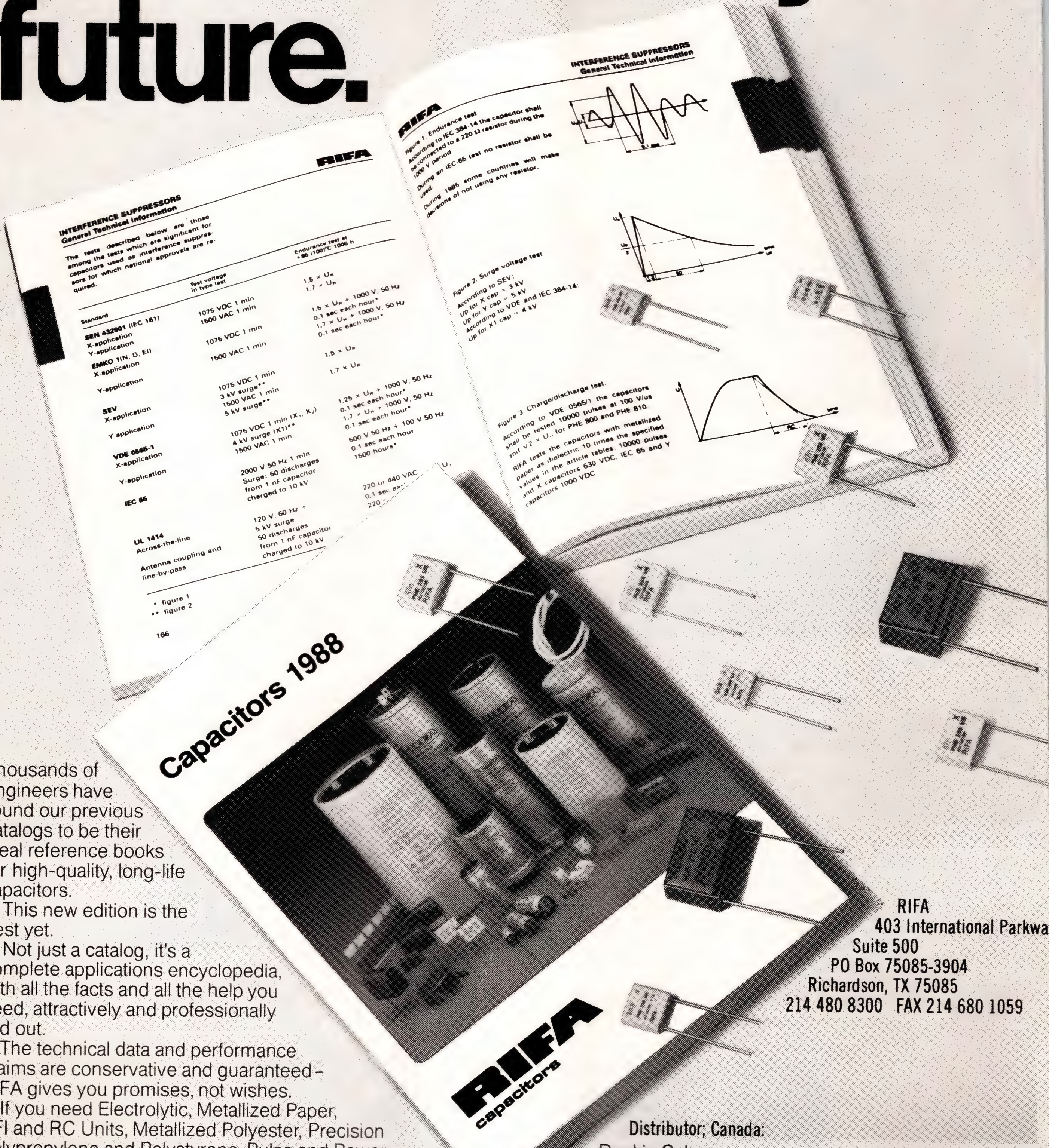
HARRIS

Harris Semiconductor: Analog - CMOS Digital
Gallium Arsenide - Semicustom - Custom

HARRIS

©1987, Harris Corporation

Dedicated to your future.



RIFA

INTERFERENCE SUPPRESSORS
General Technical information

The tests described below are those among the tests which are significant for capacitors used as interference suppressors for which national approvals are required.

Standard	Test voltage in type test	Endurance test at +85 (100)°C 1000 h
SEN 432901 (IEC 161)		
X-application	1075 VDC 1 min	$1.5 \times U_R$
Y-application	1500 VAC 1 min	$1.7 \times U_R$
EMKO 1(N, D, EI)		
X-application	1075 VDC 1 min	$1.5 \times U_R$ + 1000 V, 50 Hz 0.1 sec each hour*
Y-application	1500 VAC 1 min	$1.7 \times U_R$ + 1000 V, 50 Hz 0.1 sec each hour*
SEV		
X-application	1075 VDC 1 min 3 kV surge**	$1.5 \times U_R$
Y-application	1500 VAC 1 min 5 kV surge**	$1.7 \times U_R$
VDE 0565-1		
X-application	1075 VDC 1 min (X_1, X_2) 4 kV surge (X1)**	$1.25 \times U_R$ + 1000 V, 50 Hz 0.1 sec each hour*
Y-application	1500 VAC 1 min	$1.7 \times U_R$ + 1000 V, 50 Hz 0.1 sec each hour*
IEC 65	2000 V 50 Hz 1 min Surge: 50 discharges from 1 nF capacitor charged to 10 kV	500 V 50 Hz + 100 V 50 Hz 0.1 sec each hour 1500 hours*
UL 1414 Across-the-line	120 V, 60 Hz + 5 kV surge 50 discharges from 1 nF capacitor charged to 10 kV	220 or 440 VAC
Antenna coupling and line-by-pass		

* figure 1
** figure 2

166

INTERFERENCE SUPPRESSORS
General Technical information

RIFA

Figure 1. Endurance test
According to IEC 384-14 the capacitor shall be connected to a 220 Ω resistor during the 1000 V period.
During an IEC-65 test no resistor shall be used.
During 1985 some countries will make decisions of not using any resistor.

Figure 2. Surge voltage test
According to SEV:
Up for X cap = 3 kV
Up for Y cap = 5 kV
According to VDE and IEC 384-14:
Up for X1 cap = 4 kV

Figure 3 Charge/discharge test.
According to VDE 0565/1 the capacitors shall be tested 10000 pulses at 100 V/us and $\sqrt{2} \times U$.. for PHE 800 and PHE 810.
RIFA tests the capacitors with metallized paper as dielectric 10 times the specified values in the article tables. 10000 pulses and X capacitors 630 VDC. IEC 65 and Y capacitors 1000 VDC

Capacitors 1988

RIFA capacitors

Thousands of engineers have found our previous catalogs to be their ideal reference books for high-quality, long-life capacitors.

This new edition is the best yet.

Not just a catalog, it's a complete applications encyclopedia, with all the facts and all the help you need, attractively and professionally laid out.

The technical data and performance claims are conservative and guaranteed – RIFA gives you promises, not wishes.

If you need Electrolytic, Metallized Paper, RFI and RC Units, Metallized Polyester, Precision Polypropylene and Polystyrene, Pulse and Power Snubber Capacitors for example, send for your copy of the RIFA **1988** Capacitor Catalog.

Design RIFA into your products and you design in a future of long life and reliability.

RIFA
403 International Parkwa
Suite 500
PO Box 75085-3904
Richardson, TX 75085
214 480 8300 FAX 214 680 1059

Distributor; Canada:
Deskin Sales,
155 Clayton Drive, Markham, Ontario, L3R 5T9.
416 475 1412/496 2511. Tx 6966559.

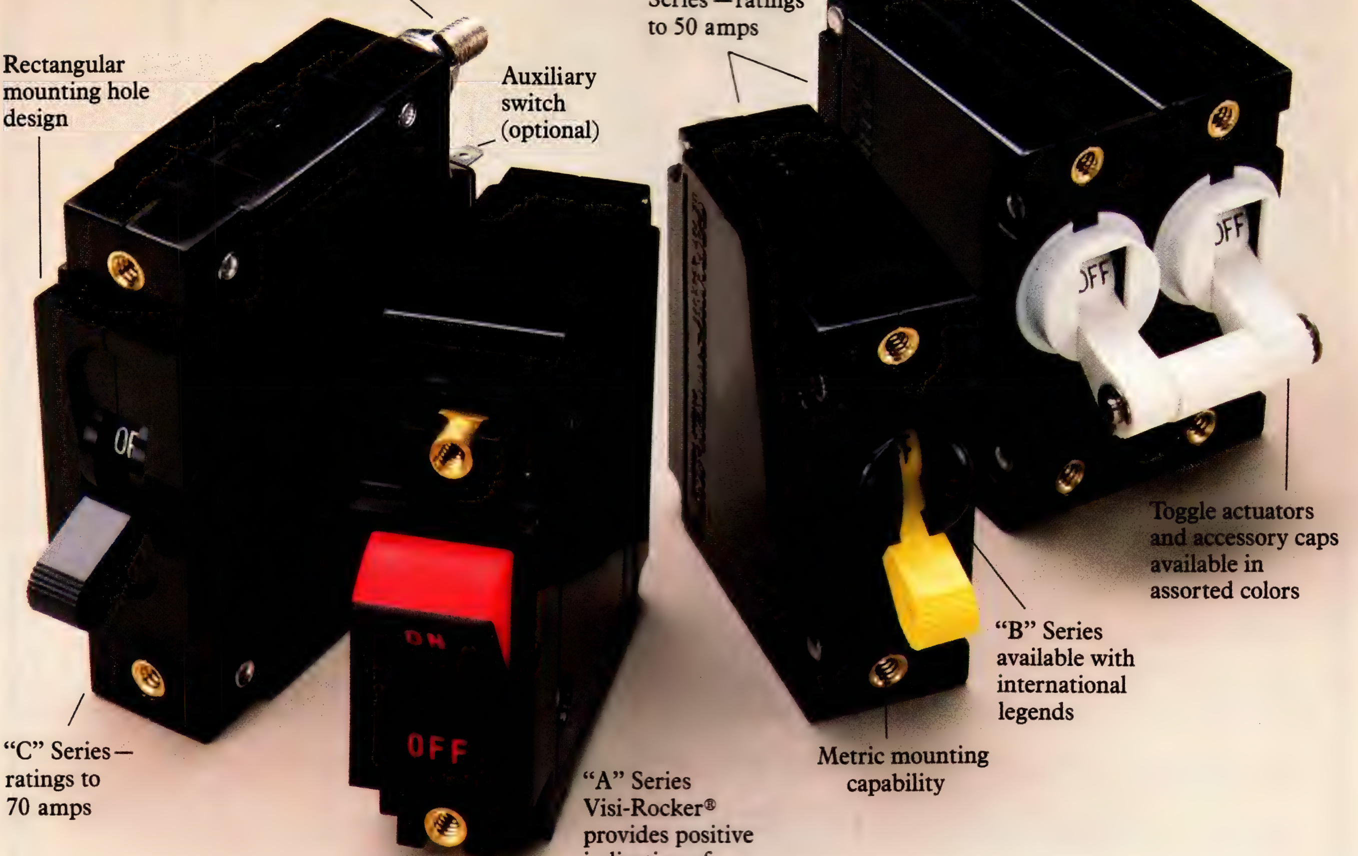
ERICSSON RIFA is a member of the Ericsson Group

CIRCLE NO 142

RIFA
quality for the future

2495

VDE Certification



Heavy duty stud terminals for high amperage applications

"A" and "B" Series—ratings to 50 amps

Rectangular mounting hole design

Auxiliary switch (optional)

Toggle actuators and accessory caps available in assorted colors

"B" Series available with international legends

Metric mounting capability

"C" Series—ratings to 70 amps

"A" Series Visi-Rocker® provides positive indication of breaker status

More Habit Breakers

Now Carlingswitch gives you even more reasons to break your old buying habits.

Like Expanded Product Range. Carlingswitch has just introduced its Series "C" Stud Terminal Magnetic Breaker with ratings to 70 amps.

Like International Approvals. Carlingswitch "B" Series Toggles and "A" Series Rockers are now VDE-certified in many standard ratings.

Like Innovative Design. Our Visi-Rocker® Breakers are an industry exclusive and give positive indication of breaker status.

Like Superior Customer Service. Expert technical advice, shorter lead times and *a recently expanded nationwide distributor network*. Just a few ways we can service your every need.

So break those old habits. Call toll-free for the name of your nearest Carlingswitch representative or distributor: **1-800-243-8160.**

For our catalog, contact Carlingswitch, Inc., 60 Johnson Avenue, Plainville, CT 06062-1156. Telephone: 203-793-9281. FAX: 203-793-9231.

CIRCLE NO 141

CARLINGSWITCH
INNOVATION BY DESIGN

LANCE NEIBAUER AND JOHN MARCONI. NEW ACHIEVERS IN SCIENCE.

we never stop asking "What if..."

Lance Neibauer. Aircraft designer. His award-winning Lancair kitplanes are the nation's top-selling homebuilts. Now using the new HP-28S, the only calculator that can do symbolic algebra and calculus, retrieve and combine graphs instantly. HP Solve lets him enter his own formulas. More than 1500 functions and 32K bytes of RAM make it the world's most powerful scientific calculator. John Marconi. Air pollution control engineer. Project leader for study on cancer-causing air pollutants. Needs to solve statistical and financial problems. Perfect job for the new HP-27S. It's the only scientific calculator with business functions. It also offers easy-to-follow menus and optional solutions books. Hewlett-Packard's new range of calculators is built for your success. For the name of your nearest Hewlett-Packard dealer, call 1-800-752-0900, Ext. 215P

Innovation takes a calculator packed with new ideas.

HEWLETT PACKARD

NEW ACHIEVERS: THE HP-28S AND HP-27S SCIENTIFIC CALCULATORS.

©1988 Hewlett-Packard Company

PG 12806

Take care when choosing controllers for flat-panel displays

Emissive flat-panel displays are well suited for applications requiring ruggedness and minimum size and weight. To optimize overall system performance, you must select a controller that's right for the job, keeping in mind that a flat-panel display's control requirements are more stringent than are a CRT's.

Colin McManus, *Digital Electronics Corp*

Flat-panel displays can outperform traditional CRTs in many applications. However, integrating a flat-panel display into a system involves far more than simply choosing the display. Selecting the proper display controller is even more important when it comes to overall system performance.

Among the factors you must consider are the flat-panel displays' physical interface requirements. A flat-panel display has a discrete pixel matrix that imposes much more stringent timing requirements than do CRTs. You must also understand how to evaluate manufacturer's performance specs, what hardware configurations are available, and what levels of software support the display manufacturer provides. With all these factors in mind, you must carefully weigh trade-offs between cost, integration time, and design-cycle time before committing to a specific controller.

The following discussion concentrates on emissive-type flat panel displays: electroluminescent (EL), plasma, or vacuum fluorescent. Although light-emitting properties vary among these display technologies, the technologies all have similar control principles. To help you understand the terms used to describe display interfaces, consider first the components of a typical display/controller subsystem.

The display itself is the piece of glass containing the basic light-emitting elements—electroluminescent film or neon-gas cells, for example. The drive electronics, which connects directly to the display, consists of basic signal-timing circuits and high-voltage interfaces. Functionally, the drivers take a fairly conventional set of video signals and transform them into the high-voltage pulses required to operate an emissive-type flat-panel display. Normally, display manufacturers sell the display and the drive electronics bundled together.

A display controller—such as the familiar CRT controller—is a circuit that takes data (such as ASCII characters) from a host computer and transforms them into video signals. Although similar in function, flat-panel-display controllers differ from CRT controllers with respect to the video-interface and timing signals that the respective devices generate.

Even among flat-panel displays, drive-signal requirements vary widely. However, some operating principles remain consistent for most drive circuits. For

Although input-signal requirements vary for different display technologies, some operating principles are consistent for most drive circuits.

example, two orthogonal sets of electrodes—the row and column electrodes—typically form the display matrix. The display medium separates these electrode sets: The column electrodes are typically on the front of the display, and the row electrodes are on the back. Each picture element (pixel) forms at the junction of a row and column electrode. The pixel emits light only if both these electrodes are activated.

A picture builds up row by row just as in a CRT. The row electrodes sequentially activate one at a time. During each row period, the column electrodes corresponding to the pixel in that row turn on. Therefore, while a CRT activates one pixel at a time, the flat panel display shows a row at a time.

The drive electronics consists of three elements—the row drivers, the column drivers, and the timing and control circuits (**Fig 1**). The row and column drivers act as the high-voltage interface circuits. The row and column drivers each contain a shift register; the column drivers also include a buffer latch. Connected together, the row drivers form a long shift register with one output set high and all others set low. Each horizontal-sync input pulse shifts the active output by one.

The column drivers also form a long shift register. In this case, however, the registers contain pixel data for the next row. When a row is complete, the horizontal-sync pulse transfers the shift-register data to the buffer latches, which are connected directly to the high-voltage outputs. During this transfer, the row drivers activate a new row.

The timing and control circuit produces the actual signals for the drivers. In addition, it acts as a safety check by blanking the display if the input video-sync signals do not fall within their proper frequency range, and it also controls power-saving functions.

Establishing contact with the timing circuit

The user interface to this timing circuit is of most concern here. Generally, the interface consists of four signals—video data, video clock, horizontal sync, and vertical sync.

Horizontal-sync frequencies typically vary from 15.6 kHz for a 512×256-pixel array to 25.6 kHz for a 640×400-pixel matrix. Usually, video-clock rates are higher than the value necessary to support horizontal sync—as high as 15 MHz for the smaller displays and 20

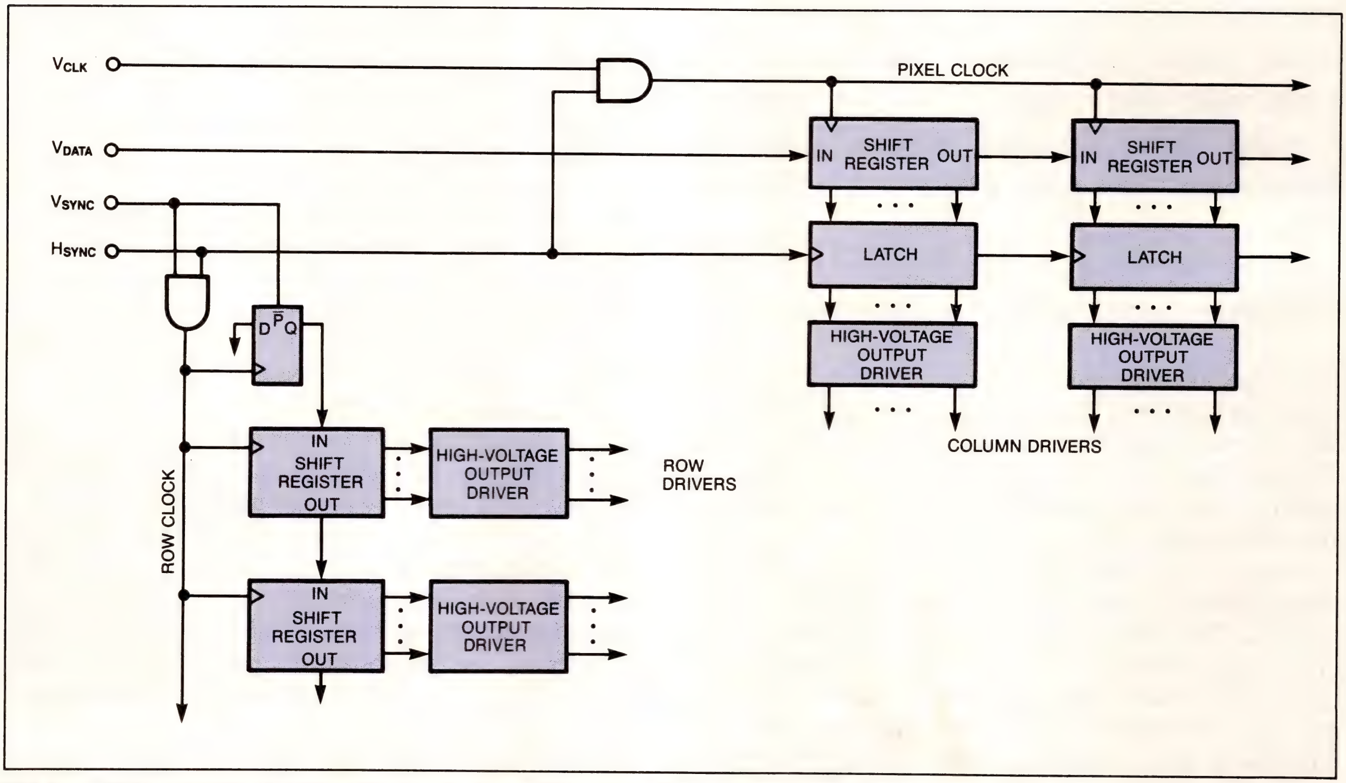


***Fig 1—A flat-panel display's drive electronics** typically includes three elements: row drivers, column drivers, and timing and control circuits.*

MHz or more for larger displays. This parameter is critical because some display controllers cannot write new data into the display memory during the image-refresh period. These controllers can only write new data during a period that corresponds to a CRT's retrace time.

At first glance, you might assume that you can use a CRT controller to drive a flat-panel display. However, input-signal requirements are much tighter for flat-panel displays, and the flat-panel display's input signals must contain more information. Two basic display-surface phenomena come into play here: The flat panel has a discrete pixel matrix while the CRT has a continuous display surface, and the flat-panel display has no border around the edge, as does a CRT.

The flat panel's discrete pixel matrix requires the controller to sample the incoming video data instead of transferring it continuously to the screen. To recognize a valid sample, the input circuit needs a video-clock signal that has a specific relationship to the data.

Because the flat panel has no edge border, controller circuitry must know precisely when blanking ends and starts—when video data is good, in other words. To satisfy this requirement, flat-panel controllers often use a blanking-control signal rather than the HSYNC signal typically found in CRT controllers.

Consequently, it's difficult to drive a flat-panel display with a controller designed for a CRT, and the results are usually disappointing. Nevertheless, two control schemes are often attempted. One technique brings out the video-clock signal and modifies the HSYNC and VSYNC signals as necessary. However, you would find this approach a difficult one to implement unless you have a thorough working knowledge of the controller circuit and access to schematics and timing diagrams. At best, this approach might yield a working prototype but not a product that's suitable for production.

In the second approach, designers employ circuitry that accepts the output signals of the CRT controller and converts them to drive the flat panel. On the surface, this task seems simple enough, but the scheme has basic problems that stem from the fact that there is not enough information implicit in the CRT signals.

Specifically, there are three issues—matrix size, video-clock generation, and regeneration of the front- and back-porch timing signals. The controller's inherent image matrix size must match that of the flat-panel display exactly. This matching is easy enough for PC-based controllers because most of the common matrix sizes for flat-panel displays are geared to PC-display standards.

When it comes to the video clock, it's a simple matter to use a PLL to produce a signal that has the right frequency. However, it is not so easy to define and maintain the right phase relationship with the video data. Because this clock latches the data into the driver shift registers, its active edge must occur while the data signal is stable. CRT controllers provide a horizontal-sync pulse for synchronization purposes. Unfortunately, its exact phase relationship to the data stream isn't controlled because CRTs have no need for phase-relationship data.

You can compensate for this shortcoming by designing a manual phase adjustment into the clock circuit. The clock signal itself must be very stable, however, because any frequency variations cause the image pixels to flutter. Such stability is difficult to attain because the synchronizing signal for the PLL (the horizontal-sync signal) is $\frac{1}{640}$ times the output clock signal.

Finally, there's the question of front- and back-porch timing-signal regeneration. For CRTs, small changes are not noticeable because of the border of unused display area around the image. For a CRT, changes in porch timing simply move the image by small amounts left or right. A flat-panel display has no such border, however, so data shifted past the edge disappears. Consequently, for a flat-panel display, a shift of only one pixel to the left may make the leading characters on each line unreadable.

With a PC-based controller, the application program running at the time sets the exact porch size. Although most applications-program writers follow the standard IBM guidelines for the porch settings, there is no way to guarantee what the exact value will be. Porch-size values also change depending on the operating mode—text or graphics. Consequently, you might have to make a manual adjustment every time the video controller switches from text to graphics mode.

The alternative, and by far the most satisfactory approach, is to design or buy a controller specifically tailored for flat-panel displays. Enigmatically, this controller circuit can employ a CRT-controller chip because the CRT chips do in fact generate all the required timing signals. The video-clock-phase and porch-timing problems just detailed arise because the required signals are not available at the output of a complete CRT-controller circuit board.

The **box,** "Examples illustrate interfacing details,"

> *Because a flat-panel display has a discrete pixel matrix, the controller must sample the incoming video data rather than transfer it directly to the screen.*

discusses how the necessary signals for a particular flat-panel display can be derived from a CRT controller chip. Over the years, various flat-panel displays' interface-signal requirements have differed in many aspects. However, you can now find more similarities. For example, panel manufacturers are starting to loosen the timing and parameter specifications. Planar (Beaverton, OR), for instance, is providing programmable back-porch delay times on its recently introduced 640×400-pixel display.

Examples illustrate interfacing details

Signal requirements vary among flat-panel displays. For example, the Planar 512×256 EL display's interface includes four active signals: video data (VID), video clock (VCLK), horizontal or row synch (HS), and vertical or frame sync (VS). These signals are supported by three mode inputs: video-signal polarity (VIDPOL), video-clock polarity ((VCLKPOL), and video input-mode select (DATASEL).

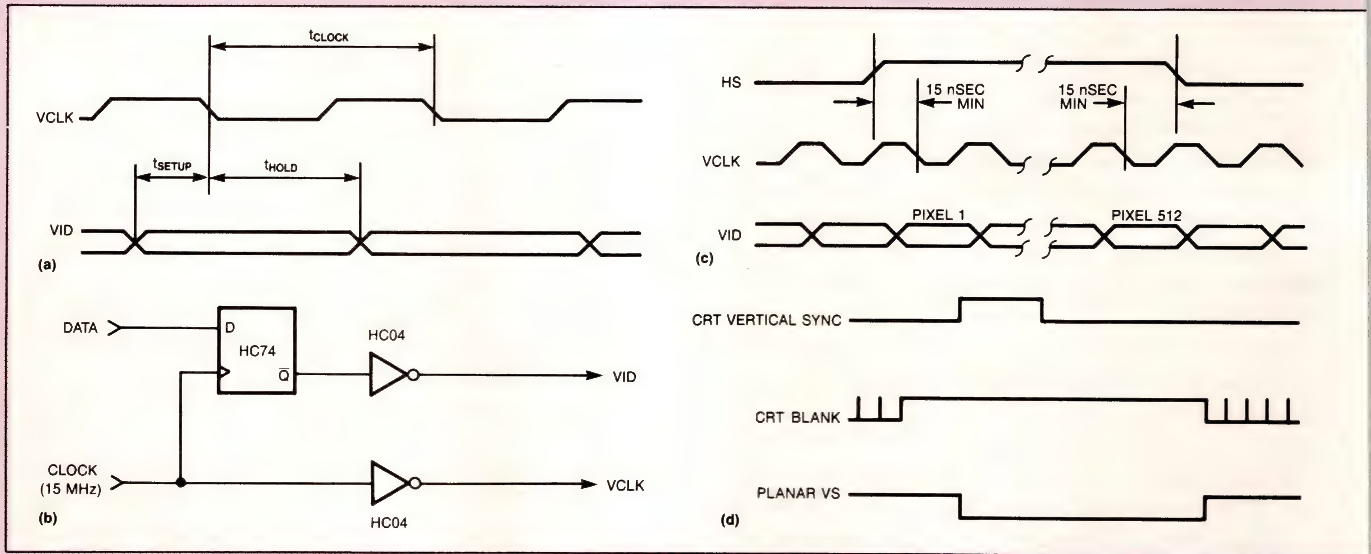
The polarity inputs, when high, ensure that a logic 1 indicates a lit pixel on video data and that the clock's falling edge latches data.

The input mode-select signal determines whether the video data will be sent on one line or two. For the 2-line mode, two adjacent pixels are sent as a pair each clock cycle. This mode effectively halves the frequency and thus can reduce EMI problems. The following discussion, however, assumes the single data-line mode.

First, the video clock signal latches data into a shift register, so the data must satisfy minimum setup and hold times: 20 nsec each with respect to the falling clock edge for the display's default modes. At a 15-MHz clock frequency, the cycle time, t_{CLK}, is only 66 nsec.

Unlike a CRT's corresponding horizontal-sync signal, the flat-panel display's HS signal must also indicate when data is valid. Each display line consists of 512 bits of valid picture data, and HS must go high at the beginning of the first valid data bit and go low at the end of the last valid data bit. Thus, this signal is more like a CRT's blanking signal than a horizontal-sync signal, and in fact the blanking signal can be used for HS, although it must pass through a synchronization stage at the controller's output, as the video data does.

VS is similar to a CRT's vertical-sync signal, but VS must in-



Timing for flat-panel displays *differs from that for CRTs. A Planar display, for example, requires that data satisfy setup and hold times **(a)**, which can be ensured by device propagation delays in a synchronizing circuit **(b)**. The HS signal also must meet stringent timing requirements **(c)**. VS can be derived from CRT-controller signals **(d)** and must meet HS/VS edge-timing requirements **(e)**; a simple circuit suffices for VS generation **(f)**. For an NEC display, timing requirements differ somewhat **(g)**.*

Fig 2 illustrates a typical flat-panel-controller output stage. This output stage can drive all popular sizes of EL displays as well as many plasma models. The circuit can readily control displays from Planar, Sharp (Paramus, NJ), GTE (Greenland, NH), Sigmatron-Nova (Thousand Oaks, CA), Finlux (Cupertino, CA) and World Products (distributor for NEC, Sonoma, CA).

In general, display controllers fit into one of two categories—dumb controllers and smart controllers. Performance and architecture, overhead requirements,

dicate when the first line of valid data occurs.

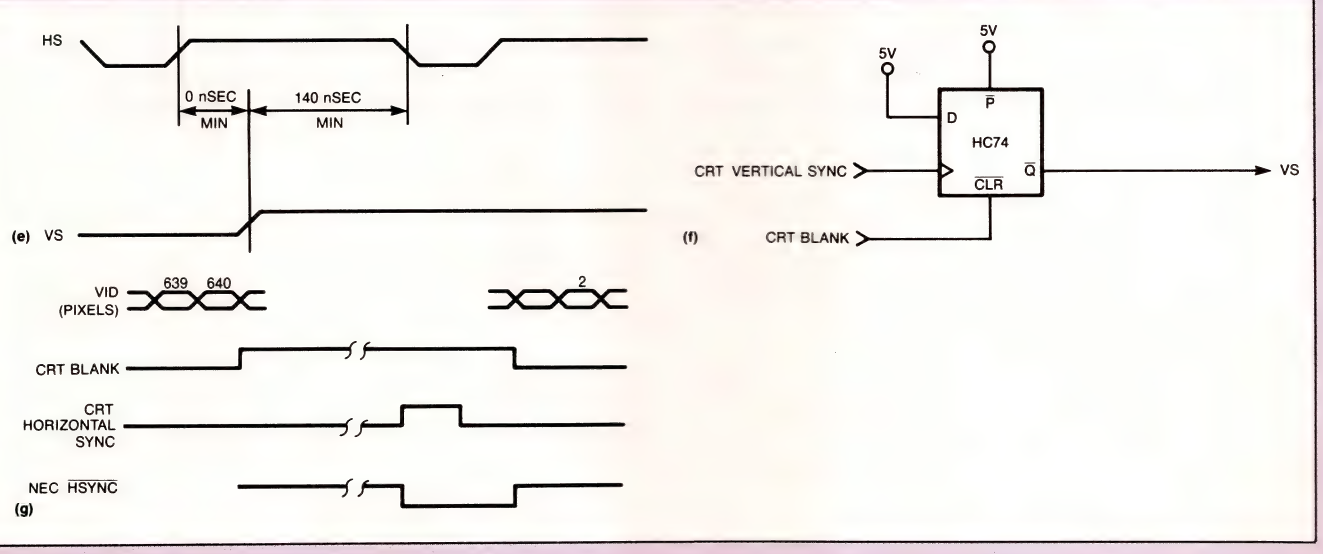
Control of the Planar display also requires care in setting line-count parameters. The display must receive 260 HS pulses, requiring that—if a blanking signal is used for HS—the controller chip's active-line parameter be set to 260 instead of 256. (Only the first 256 lines will be displayed, so it's not important what data reside on the last four lines. Note too that lines beyond 260 are not only not necessary—they may cause the display to flicker.) In addition, the duration of VS should be kept short —to no more than three or four HS periods.

Timing requirements differ somewhat for the NEC 640×400 Model PD640G400CA-100A display. It lacks the Planar display's mode lines but adds a brightness-control line.

The NEC unit's $\overline{\text{HSYNC}}$ signal indicates an end of a row, as does the Planar unit's HS signal, but $\overline{\text{HSYNC}}$ also affects brightness: When low the display is blanked, so for maximum brightness $\overline{\text{HSYNC}}$'s low state should be kept as short as possible.

In addition, although the leading and trailing edges of Planar's HS define the end and beginning of valid data, only the trailing edge of $\overline{\text{HSYNC}}$ is critical (it defines the start of valid data), so the leading edge can be delayed after the end of valid data. For best results with the NEC display, a CRT controller chip's parameters should be set so that horizontal retrace or blanking time consists of a long front porch followed by a short sync pulse and back porch.

The NEC display's brightness input is driven by an on-time duty-cycle controller; the input is a variable-length pulse signal that's synchronized with $\overline{\text{HSYNC}}$. Feeding $\overline{\text{HSYNC}}$ into a one-shot can generate the brightness input.



In general, display controllers fit into one of two categories—dumb controllers and smart controllers.

and ease of application are the main factors that define these categories.

Many designers rely on drawing-performance specs to evaluate display controllers. It's very difficult to compare these speed parameters on an apples-to-apples basis because vendors usually measure and report performance differently. For example, there are three popular measures of performance—pixels per second, vectors per second, and text characters per second.

Although the pixel/sec parameter is commonly used to specify performance, it is probably the most misleading because pixels are not written continuously but in bursts. Unless a system can continuously write pixels at the specified pixel/sec rate, the average number of pixels per second will be much lower than the burst rate. Manufacturers often publish the burst rate rather than the more important average rate.

The drawing operation itself also greatly influences pixel rate. For example, a simple block-fill operation can run at a much higher pixel rate than a vector-drawing routine. You can write as many as 16 or 32 pixels in a single cycle for a block-fill operation while you have to individually write each pixel for a vector-draw operation. Obviously, it's important to know the relationship between the published pixel/sec rate and the drawing operation.

A system's vector/sec drawing capability is a much better measure of overall performance. This parameter is much more meaningful because it incorporates both host-interface overhead and drawing setup time. Normally, a vector length of 25 to 40 pixels is adequate for measuring vector drawing speed. You should measure performance by continually sending instructions for at least several seconds and then calculating the average time it takes to draw one vector. It's important to use random vectors here to maximize the setup overhead—using the time it takes to draw a single vector is not a valid measure of performance.

The text-character/sec spec is also a useful parameter for evaluating and comparing text-display speeds. As with vectors, it's important to consider the average speed over a time period rather than the time it takes to display a single character.

Architectures aren't all the same

With a dumb controller, the host has to do all of the display processing. A typical unit consists of a 2-port video memory, an automatic refresh controller that continuously cycles through the video memory and sends data to the display, and logic circuitry that generates the four display-control signals. The refresh controller can only read the video memory; the host has to draw all the figures and graphics in the video memory. Most popular graphics boards available for personal computers are examples of dumb controllers.

Because the host must generate the display image, a dumb controller places a considerable burden on the host. You can use a character-generator ROM to generate text easily, but it is much more difficult to generate graphics. An application involving a powerful, lightly burdened host processor and readily available graphics software is the ideal environment for the dumb controller. The personal computer fits this profile well.

Smart controllers minimize host overhead tasks by

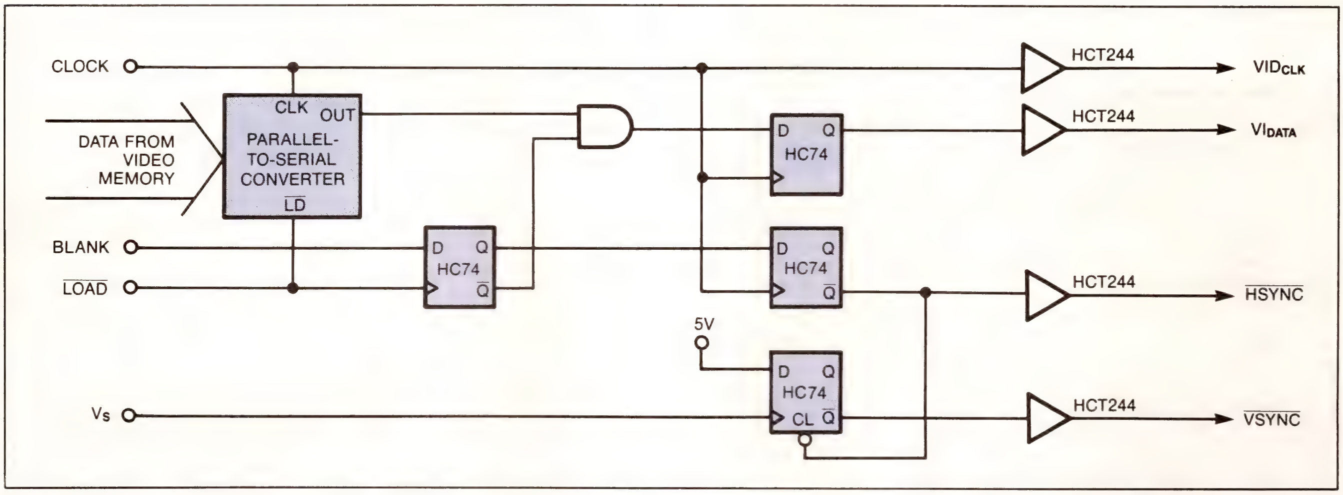


Fig 2—Flexibility is a key feature *of today's flat-panel controllers. This output stage, for example, can drive all popular sizes of EL displays as well as many plasma-type devices.*

Make it friendly.
Touch it.

Design a system that gives you a competitive edge. Make it simple to use. Easy to learn. Make it friendly. With a touch input system from Carroll Touch, the world's leading OEM supplier of touch products.

Discover the full line of solutions Carroll Touch offers. From infrared to overlay touch products. Select from a wide range of standard add-on units in a variety of sizes. Or from a line of fully integrated computer displays equipped with touch. Or specify your own unique requirements.

Once you've chosen the Carroll Touch product that's right for your system, you'll discover even more. Exceptional quality and ruggedness. High reliability. Low maintenance. Making touch more affordable and cost-effective than ever.

Whether it's sophisticated test equipment for automotive technicians. Or a medical diagnostic system for patient care. Make your next system friendly. Touch it. Begin by calling 512/244-3500.

See us at Electro Booths 523 and 525

Carroll Touch

a subsidiary of **AMP** Incorporated

P.O. Box 1309
Round Rock, Texas 78680
512/244-3500 Telex 881906
CIRCLE NO 209

Smart controllers minimize host overhead tasks by providing local intelligence at the display-control level.

providing local intelligence at the display-control level. There are two popular architectures.

There's smart and then there's smart

Low-end smart controllers consist of a general-purpose microcontroller coupled with a dumb refresh unit and video memory. You can program this typical low-end controller with a limited set of drawing algorithms that reside in its program memory. Such a controller might include simple algorithms for drawing lines, circles, rectangles, and so on. Although this low-end smart controller does ease the host's overhead burden, it must still implement all the drawing algorithms in software and also handle all communications with the host. As a result, the microcontroller's speed limits display performance. The block diagram in **Fig 3** illustrates a typical low-end smart controller.

The high-end smart controller couples a general-purpose processor and a specialized drawing processor into a pipelined architecture to achieve high-speed performance. Using this approach, the controller can execute the three main program sections of the DDA (digital differential analyzer), a commonly used vector-drawing algorithm, simultaneously. The drawing processor computes the coordinates of the next pixel while the previous pixel is being written into memory. In parallel, the general-purpose processor handles the setup for the next figure. Tasks are done in parallel; while the DDA processor is calculating the next bit location to modify, the memory-control interface is performing a read-modify-write operation for the current one. In contrast, a low-end smart controller system only modifies the video memory once each time the microprocessor goes through the algorithm's loop.

The block diagram in **Fig 4** exemplifies a high-end smart controller. Note that one of the two processors is dedicated to I/O control and display-list processing. It communicates with the host via a serial or parallel interface. The host communicates to the controller via a high-level ASCII-based command set. The graphics processor provides parallel display processing and control functions.

Don't overlook software-support considerations

Design-cycle time is an important consideration when choosing a flat-panel-display system for any application. Design cycle time for product introductions is often short given today's market demands and competitive pressures. Because the development effort for custom software can easily exceed one man-year, it's important for designers to seriously consider the trade-offs between custom display systems and off-the-shelf systems.

Although a dumb controller usually minimizes system hardware costs, it can also extend design cycle time because it lacks a high-level command set and other features. In addition, it burdens the host with display-control tasks. Smart controllers can significantly reduce design-cycle time while simultaneously maximizing the level of overall system performance.

When evaluating either low- or high-end smart controllers, it's important to look for built-in terminal-

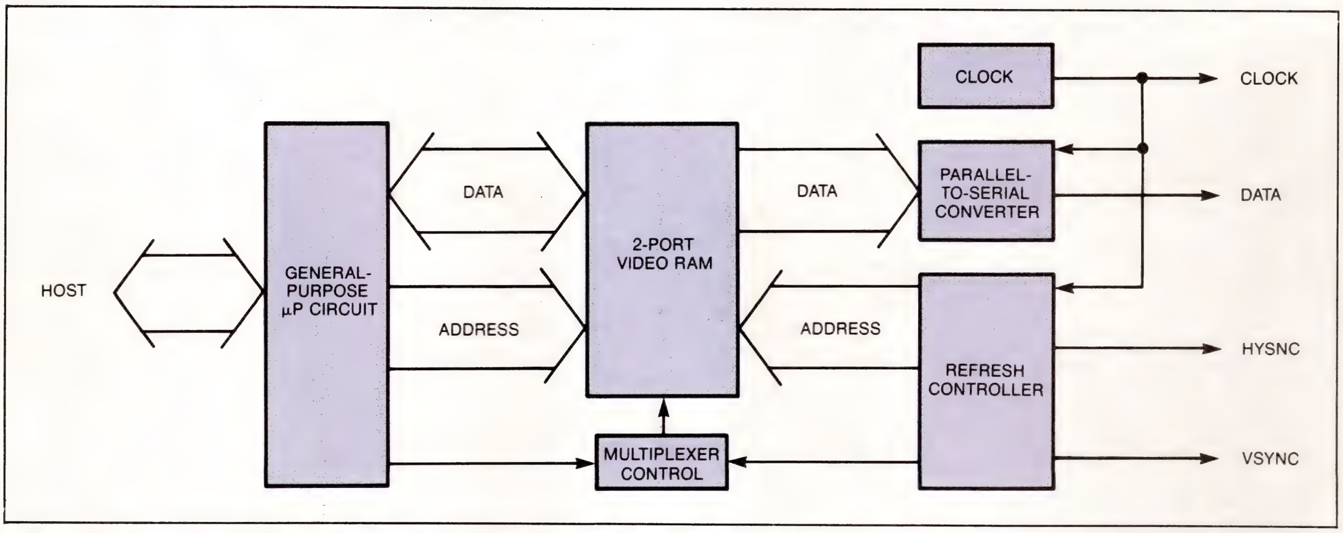


***Fig 3—Although this low-end smart controller eases** host-overhead tasks, it must still implement all the drawing algorithms in software and handle all communications with the host.*

Nothing will change but the name on the door.

Same RF products, Same RF people, Same RF places.

It's a strong signal for continuity of your TRW sales, support and service channels, but now with Motorola's total resources added to service and support your RF semiconductor needs even better.

...Same RF numbers too:

213/536-0888 ext. 430—Lawndale 56 39 58 26—Bordeaux

MOTOROLA

Motorola RF & Optoelectronic Products Division/RF Devices—Lawndale, CA
Motorola Semiconducteurs—Bordeaux, S.A., France

A high-level graphics and control command set is essential for developing applications quickly and cost effectively.

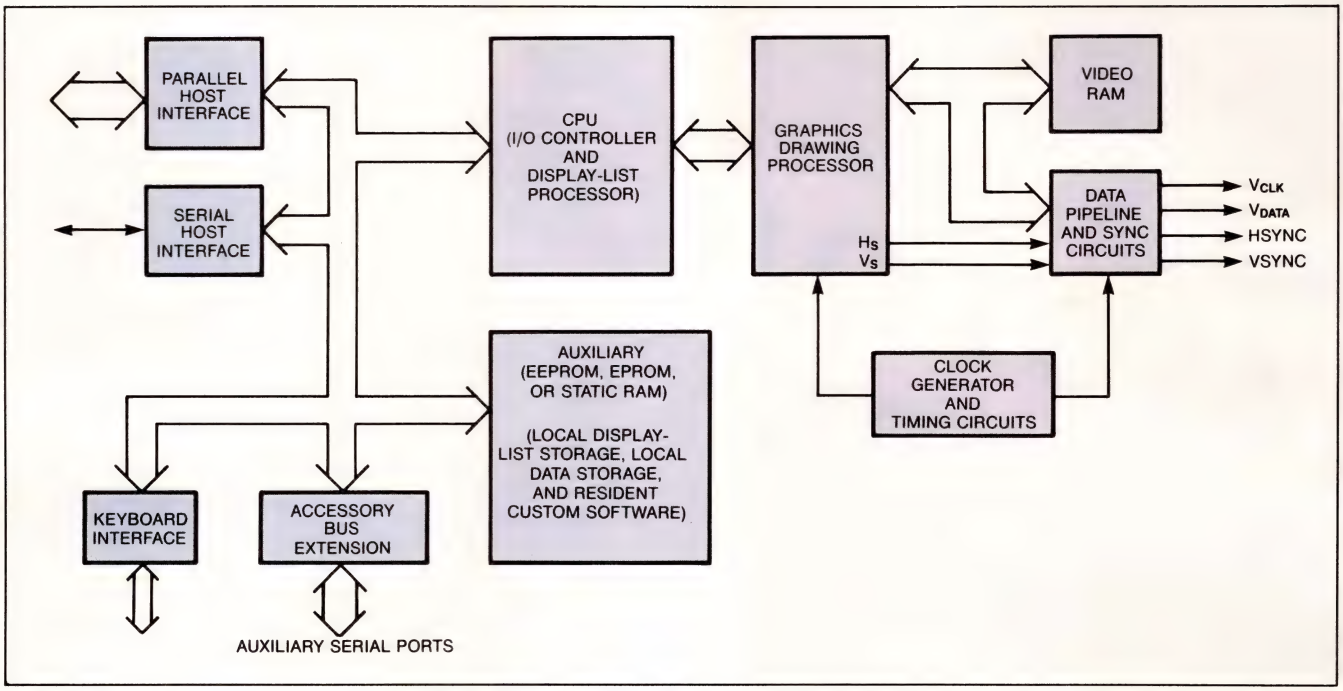

PARALLEL HOST INTERFACE
SERIAL HOST INTERFACE
CPU (I/O CONTROLLER AND DISPLAY-LIST PROCESSOR)
GRAPHICS DRAWING PROCESSOR
Hs
Vs
VIDEO RAM
DATA PIPELINE AND SYNC CIRCUITS
VCLK
VDATA
HSYNC
VSYNC
AUXILIARY (EEPROM, EPROM, OR STATIC RAM)
(LOCAL DISPLAY-LIST STORAGE, LOCAL DATA STORAGE, AND RESIDENT CUSTOM SOFTWARE)
CLOCK GENERATOR AND TIMING CIRCUITS
KEYBOARD INTERFACE
ACCESSORY BUS EXTENSION
AUXILIARY SERIAL PORTS

Fig 4—High-end smart controllers typically employ a dual-processor design. *One processor controls all I/O tasks while the second provides parallel display processing and control functions.*

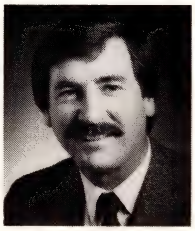
emulation capabilities, a high-level graphics and display-control command set, and other special features. Standard terminal-emulation capability allows you to easily interface the display and controller to existing applications routines.

A high-level graphics and display-control command set is essential for developing and revising applications quickly and cost effectively. In addition to graphics primitives (such as vector, arc, and circle) and operations (such as fill), the controller should provide window and clipping operations and DMA operations to video memory.

The ability to locally store frequently used, host-accessible frames (display lists) is another important feature to look for in a smart controller. Storing display frames locally removes a significant burden from the host because it negates the need to transfer the display list for the frame—the host merely sends to the controller a single command that indicates which frame to display. The controller then locates the display list in its local memory and uses it to generate the display.

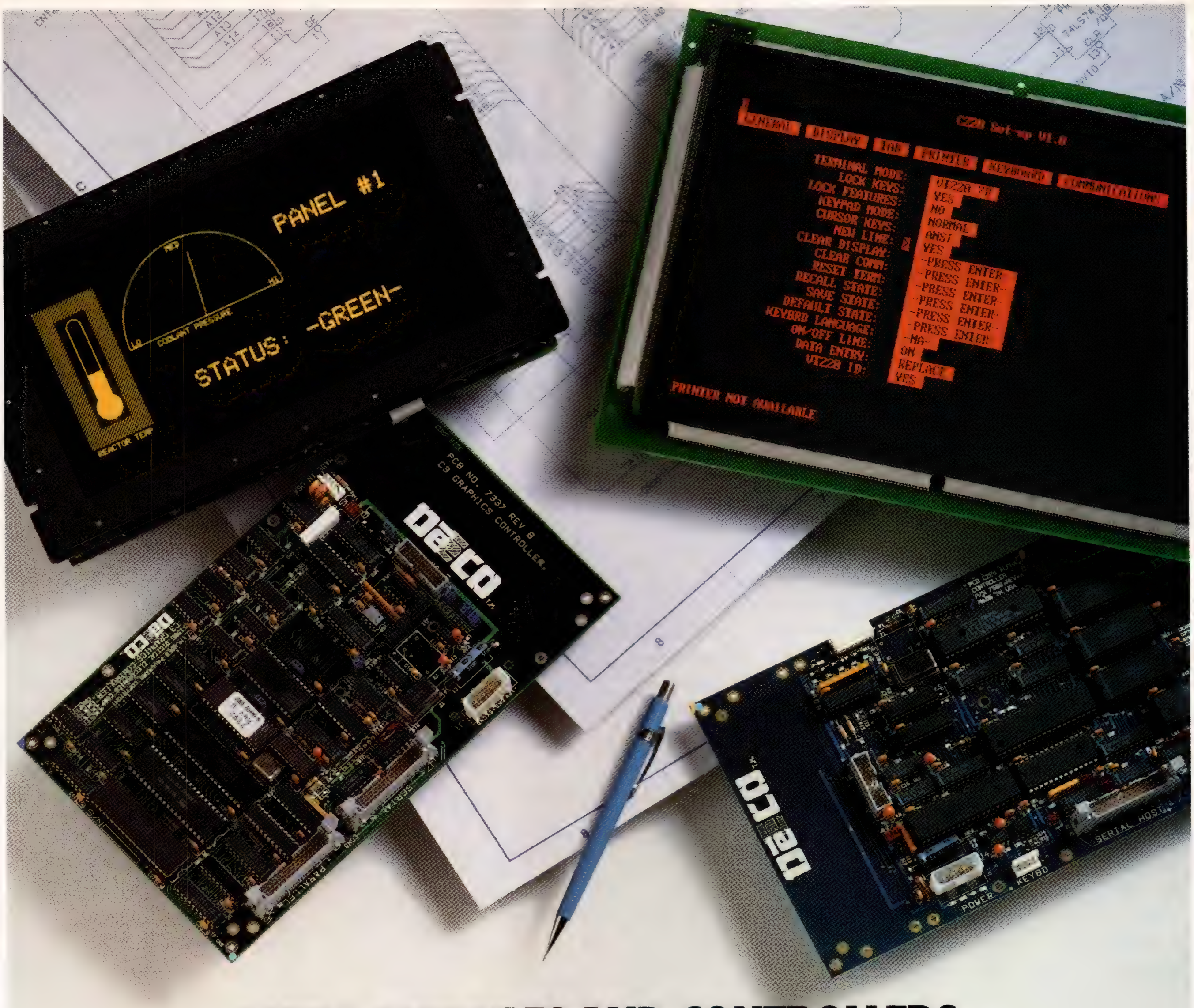
There are a few other issues to consider when evaluating smart controllers. There's the interface question, for example. Does the controller offer standard serial and parallel ports for fast and easy connection to the host system? Can you use all of the ports simultaneously? If operator input comes in whole or in part from a keyboard, you must consider whether the controller offers a straightforward keyboard interface. Flat-panel display applications often call for a touchscreen interface, so you should consider whether the controller supports touchscreen input. **EDN**

Author's biography



Colin McManus is vice president of engineering at Digital Electronics Corp (Hayward, CA). With the company five years, he was previously employed at Humphery Instruments. Colin holds BSEE and MSEE degrees from Queens University in Belfast, Ireland. While four children take up a good deal of his spare time, Colin busies himself with carpentry projects and reading history when time is available.

Article Interest Quotient (Circle One)
High 488 Medium 489 Low 490



DEECO MODULES AND CONTROLLERS. SINGLE-BOARD SOLUTIONS FOR MULTIPLE TECHNOLOGIES.

When it comes to finding a single solution to your multiple flat-panel display needs, the choice is DeeCO modules or controllers. DeeCO controllers easily interface to either electroluminescent or plasma displays, eliminating the need for time-consuming modifications and speeding product design.

Drawing Graphics and VT100 Emulation Controller.

The C3 controller makes your software development easier. Over 200 simple ASCII handler commands enable powerful capabilities for advanced flat-panel graphics and VT terminal text applications.

The system draws lines, arcs, circles, inside and outside paint and several styles of fill patterns, plus 16 levels of character zoom and displays text on any 45-degree angle. Internal frame storage saves frequently-used screens, which frees up valuable host time.

If your application is in harsh environments and requires operator interaction, DeeCO's SealTouch options provide a complete system solution.

VT220 Emulation and Character Graphics Controller.

The C220 controller emulates VT220 terminal operation, supporting 80 columns and 25 lines of text. Plus you can choose from multiple character sets for ASCII, multinational, graphics and Hebrew.

The system software designer will appreciate features such as, "window" and non-destructive "overlay" primitives.

Multiple I/O ports for host, keyboard and printer interfaces provide expanded design flexibility and convenience.

To find out more about DeeCO display solutions, call or write today. Because when it comes to modules and controllers for multiple technologies, we have one solid solution.

DeeCO®

Digital Electronics Corporation, 31047 Genstar Road, Hayward, CA 94544-7831 (415) 471-4700

DeeCO is a registered trademark of Digital Electronics Corporation. VT220, VT100 are trademarks of Digital Equipment Corporation.

CIRCLE NO 208

DC TO 6 GHZ TRANSIENT EVENT CAPTURE. A WORLD WHERE TEK STANDS ALONE.

In a world of extremely high-frequency, ultra-fast signal transitions, there are two instruments that thrive: the Tek 7250 Transient Digitizing Oscilloscope and Tek 7912HB Transient Waveform Digitizer.

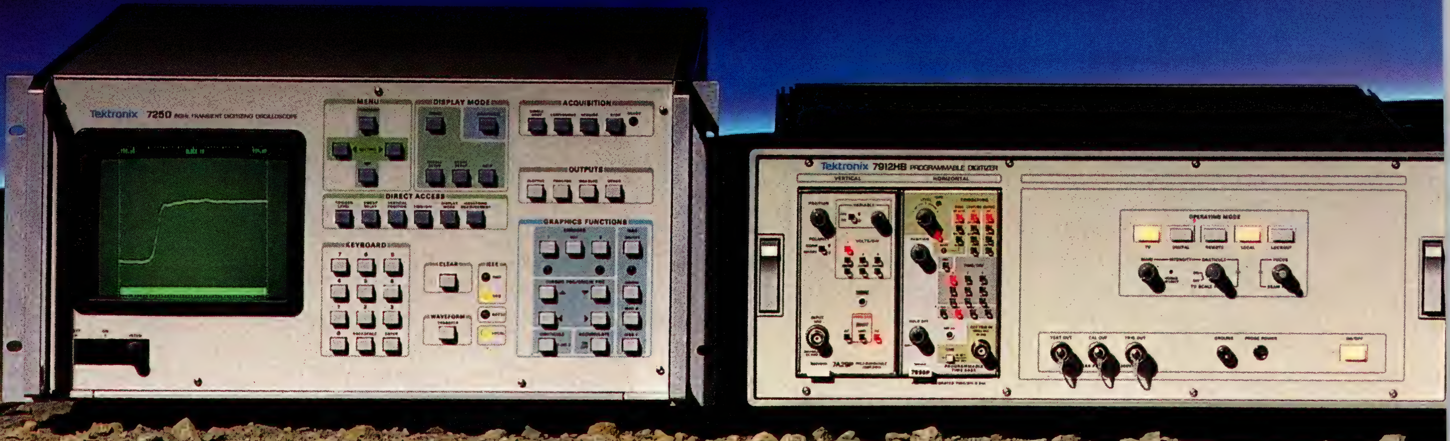
No other digitizing oscilloscope can automatically capture and record lightning-fast events whether single-shot or low-rep rate that more and more applications—from particle physics and lasers to semiconductor characterization—regularly encounter.

The 6 GHz Tek 7250 can capture transients of 50 ps rise time at 1 picosecond/point; with 11-bit vertical and 9-bit horizontal resolution. Menu-driven, with on-board measurements and integral monitor, it is easily the highest performance transient digitizing oscilloscope ever made.

The Tek 7912HB achieves 10 ps/point time resolution, allowing capture of events with transitions of less than 575 ps. In addition to its 750 MHz analog bandwidth, triggering capabilities and 10 waveform-per-second data transfer rate, the 7912HB offers the plug-in module flexibility of a Tek laboratory oscilloscope, such as the new 7A29P programmable amplifier.

Characteristics	7250	7912HB
Analog Bandwidth	6 GHz	750 MHz
Rise Time	50 ps	575 ps
Fastest Time/Point	1 ps/pt.	10 ps/pt.
Max. Points/Second	1000 GS/s	100 GS/s
Vertical Resolution	11 bits	9 bits
Input Signal Range Vertical	5V full scale, 10 divisions	80mVto 8V full scale, 8 div.
Input Sensitivity	500mV/div.	10mV/div. to 1V/div.
Fully Programmable	Yes	Yes

For more information on the world of Tek digitizing, call 1-800-835-9433. Or contact your Tek representative.



Copyright © 1987, Tektronix, Inc. All rights reserved. WDA-808

Tektronix
COMMITTED TO EXCELLENCE

CIRCLE NO 207

In seventeen countries around the world, the unparalleled research and development capabilities of CIBA-GEIGY Group Companies are advancing the technology of electronic chemicals and processes.

Layers of electronic magic held fast by Araldite® resins.

Today's printed circuits must combine extremes of circuit density with flexibility, strength and precision. The secret is Araldite laminating resins, products of CIBA-GEIGY research. These resins blend the best mechanical and dielectric properties with resistance to hot-air levelling and a steadfast refusal to delaminate even when exposed to solder baths. Result: lighter, stronger and more reliable circuits.

Tomorrow's photopolymer solder mask today: The Probimer® series.

A comprehensive system capable of masking printed wiring boards of exceptionally high density with little possibility of solder bridging or distortion, the Probimer technology provides an extraordinary level of fidelity to the photographic contours of the original. Further Probimer advantages: a tough protective coating imbued with flame retardance and a high level of resistance to chemical and environmental attack.

High-purity protection: The superb Aratronic® encapsulation systems.

Heat, cold, extremes of pressure and environmental exposure: These are just a few of the adverse conditions an electronic component may have to endure. And endure it will, when protected with high-purity Aratronic encapsulation systems. These systems offer negligible shrinkage during cure, excellent adhesion to metals and other materials, and stalwart resistance to chemical attack.

Improved cost-effectiveness and reliability for semiconductors and hybrid circuits: Probimide® microelectronic systems.

Probimide polyimides are an advanced high-purity mask and photopolymer coating developed especially for the stringent requirements of today's semiconductors and hybrid circuits. They provide heat resistance up to 450°C and their photoimageability has resolution capability into the micron range, hundreds of times better than the best photographic film.

Pulling it all together: Furane Products specialty polymers.

For packaging and assembling electronic components, CIBA-GEIGY's Furane Products Company formulates specialty polymeric materials to meet the ever-increasing demands of industry.

Uralane® conformal coatings can be used in most hostile conditions of heat and humidity. Epibond® die attach adhesives meet demanding military specifications for thermally conductive/electrically insulating adhesives.

A global capability: Wherever there is technology, there is CIBA-GEIGY.

CIBA-GEIGY Group Companies literally circle the globe with highly sophisticated technological and service capabilities. For more information, please contact: In the U.S.A. CIBA-GEIGY Corporation, Electronic Chemicals Group, Three Skyline Drive, Hawthorne, New York, 10532. Telephone: (800) 431-1900, (914) 347-4700 in New York. In other countries, please contact the local CIBA-GEIGY Group Company or CIBA-GEIGY Ltd., Electronic Chemicals (KA 5.6), 4002 Basel, Switzerland, Telephone: 061/362850.

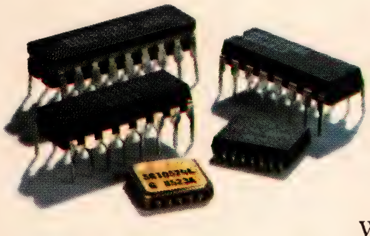
CIBA-GEIGY

The sun never sets on
CIBA-GEIGY'S
world of electronic chemicals

CIRCLE NO 206

Who delivers PWM's in ceramic, plastic and surface mount?

The General does.



Isn't that just what you would expect from the inventor of the pulse width modulator?

Now we are in the third generation of PWM's with a truly broad line. Fourth generation parts are on their way.

The General processes PWM's to 883B, Rev. C and Class S. All standard package types are offered including SOIC, LCC, and PLCC.

All parts are available on short lead times. Sample quantities for evaluation purposes can be shipped immediately.

Built in QPL Plant.

You are assured quality. MIL-M-38510 approval has been granted for our plant to produce JAN parts. JAN products include the MIL-M-38510/10103 BGA and the MIL-M-38510/13001 BEA.

A PRODUCT MATRIX TO BUILD BY.

Military Temp Range (-55° C to 125° C)	Commercial Temp Range (0° C to 70° C)
Voltage Mode	
SG1524J	SG3524N
SG1524BJ	SG3524BN
SG1525AJ	SG3525AN
SG1526J	SG3526N
SG1527AJ	SG3527AN
SG1840AJ	SG3840AN
Current Mode	
SG1842J	SG3842N
SG1843J	SG3843N
SG1846J	SG3846N
SG1847J	SG3847N

Procedures developed by Silicon General to achieve this status include quality assurance, testing, burn-in, careful assembly and fabrication programs and other elements of high reliability manufacturing technology.

New catalog available.

Ask for your free copy, please address Silicon General, 11861 Western Ave., Garden Grove, CA 92641. Phone (714) 898-8121. TWX 910-596-1804. FAX (714) 893-2570.

SILICON
GENERAL

CIRCLE NO 205

Mini dc/dc supplies simplify redundancy in parallel systems

You can significantly increase the reliability of an uninterruptible power supply (UPS) by connecting dc/dc converters in parallel to implement redundancy. Miniature, on-card dc/dc converters make it possible to design parallel-redundant systems that offer higher efficiency than that attainable from conventional UPS designs.

Lars Thorsell, *Rifa Power Products*

A source of uninterrupted power is increasingly becoming a requirement for computing systems. A total or even partial power failure, and the subsequent loss of data, can be catastrophic for many applications. In such applications, you must address the problem of fault tolerance in your equipment design. Many of these critical applications rely on uninterruptible power supplies (UPS) to satisfy the requirement of continuous operation. Miniature, on-card dc/dc converters, connected in parallel, provide a highly reliable, redundant power-distribution system.

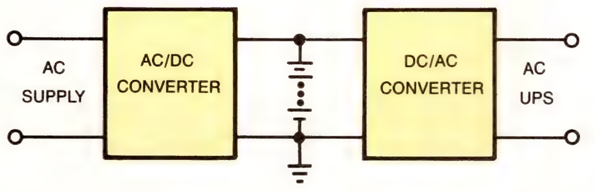
Conventional UPS systems, on which many of these critical applications rely, suffer from the reliability limitations of their internal electronic circuitry. You can increase the reliability of a power-distribution system by introducing parallel redundancy. In many situations, however, this solution introduces new difficulties of thermal management, size, efficiency, and cost. Miniature dc/dc converters make it possible to design UPS systems that exhibit efficiencies as high as 65%, as compared with the 40% that's typical of conventional UPS systems that use parallel redundancy. Before exploring these efficient UPS designs, it might be useful to gain some insight into the design of a conventional UPS system.

Conventional UPS has shortcomings

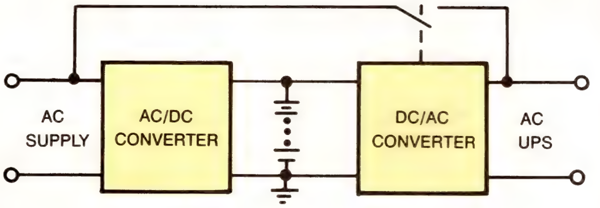
A conventional UPS (**Fig 1**) consists of an ac/dc rectifier that also serves as a battery charger; a battery, and a dc/ac inverter. An on-line UPS (**a**) operates continuously and provides a power-line conditioning filter as well as battery back-up. A standby UPS (**b**) has a bypass switch that switches in the UPS only when a line failure occurs. The start-up time of a standby UPS is usually shorter than the hold-up time of the principal supply in the equipment, so no power interruption occurs during the switchover.

Although a conventional UPS solves problems related to interruptions or bad conditions in the main ac power line, it cannot deal with faults that occur in the power-conversion circuits. The overall power system requires a dc/ac converter after the battery in the UPS, followed by an ac/dc supply in the equipment (**Fig 2**). This dual conversion process is the weakest link in the overall power system because of the electrolytic filter

Although a conventional UPS solves problems related to the main ac line, it cannot deal with faults in the power-conversion circuits.



(a) ON-LINE TYPE



(b) STANDBY TYPE

Fig 1—A conventional UPS comes in two configurations. *An on-line type* ***(a)*** *operates continuously, and provides line filtering and battery back-up. A standby type* ***(b)*** *has a bypass switch that switches in the UPS only in the event of a line failure.*

capacitors—often operated at levels near the capacitors' specified operating limits—used to reduce line-frequency ripple. Electrolytics are also required for long hold-up times in the ac/dc supply.

Further, the dual power conversion lowers the overall efficiency of the power system, and this reduced efficiency also contributes to lower reliability figures. Inverter circuits used in the UPS typically have an MTBF (mean time between failure) of 50,000 hours, and switch-mode supplies typically have MTBFs from 50,000 to 100,000 hours. In fact, the down time attributable to power-conversion faults can be four times the down time caused by interruptions in the main ac supply (see **box,** "Weak links limit UPS reliability").

To overcome the down-time problem, UPS designers build parallel-redundant functions into the weak links of the power system **(Fig 3).** Successful parallel redundancy depends on the use of redundant parts that are easily repairable or replaceable. In calculating the MTBF of the system, it's safe to assume that faults occur one at a time and that supervisory circuits with alarms detect the fault occurrences. The MTTR (mean time to repair) must be many times lower than the MTBF.

Because doubling up all the weak-link circuits leads to bulkiness as well as high costs, designers often duplicate only the principal power-supply unit **(Fig 4).** Note, however, that the nonduplicated inverter substantially reduces the overall reliability figures.

The outputs of the redundant power supplies connect to the load through ORing diodes. The diodes are required because of the existence of relatively low-reliability components, such as electrolytic capacitors, on the output side of the power supplies. The voltage drops and power dissipation attributable to the diodes can contribute appreciable losses in a high-power system.

Raising redundancy reliability

A more reliable UPS is illustrated in **Fig 5.** The ac/dc supply in the equipment receives back-up from a battery and battery charger. This back-up scheme eliminates the need for large electrolytic units acting as hold-up capacitors. The dc voltage from the supply feeds directly to dc/dc converters, thereby eliminating the dual power-conversion reliability figures from the overall reliability calculations.

Achieving redundancy is a matter of connecting dc/dc converters in parallel. The dc/dc converters are

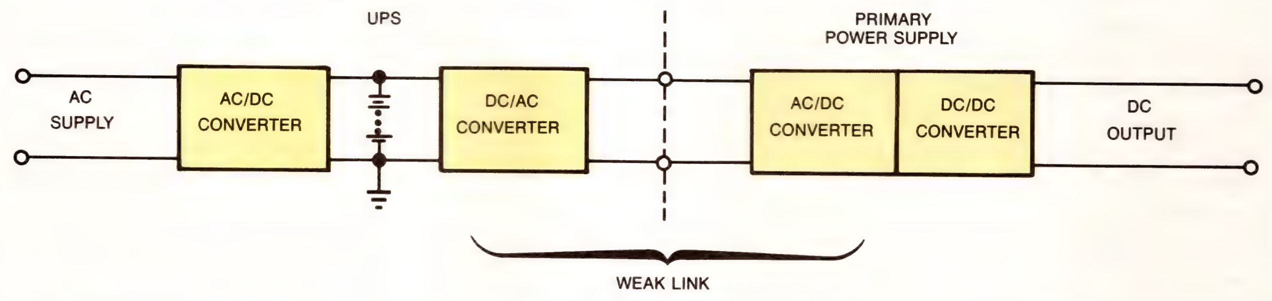


Fig 2—The weak link in a conventional UPS system *is the dual power-conversion circuitry. The electrolytic filter capacitors used to reduce line-frequency ripple and to provide long hold-up times are the main contributors to reliability compromises in these systems.*

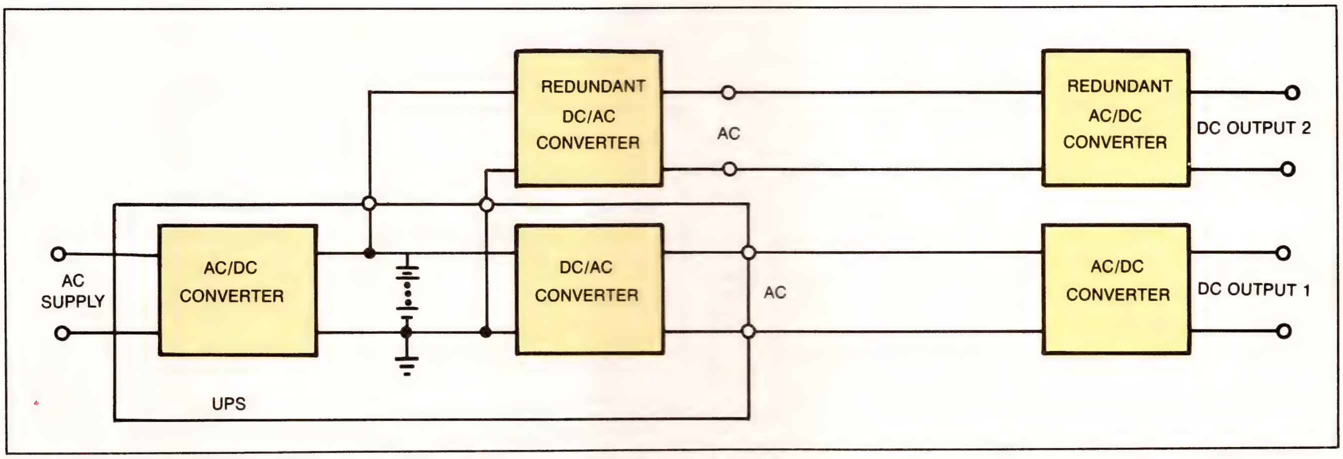


*Fig 3—**Building redundancy into a conventional UPS system** can be bulky and expensive. In this configuration, both the dc/ac inverters and the ac/dc output rectifier supplies have redundancy.*

mounted on system cards to conserve space. They use high switching frequencies, and can therefore use smaller and more reliable (vs electrolytics) ceramic capacitors to eliminate ripple-frequency components. For example, the PKA Series of dc/dc converters uses a 300-kHz switching frequency in a full-wave bridge arrangement. This series quotes an MTBF of 200 years (approximately 1.75 million hours). (See **box,** "Converter switching frequencies creep upward".)

The battery directly feeds the dc/dc converters, which are connected in parallel to the load without the use of ORing diodes **(Fig 6).** This connection method is possible thanks to the use of reliable ceramic capacitors on the converters' outputs. The system achieves redundancy by adding only one extra unit instead of duplicating the entire power supply. To build a 100W system, five 25W dc/dc converters, connected in parallel, are enough to ensure redundancy. Only 125W power capability is needed, compared with the 200W needed to double up on the power supplies.

Distributing the individual dc/dc converters around the various system boards enhances the system reliability. The heat dissipation is spread evenly throughout the system. This uniform distribution eliminates hot spots that would arise from the concentration of bulky power units.

Fig 7 illustrates a redundant system that uses on-card dc/dc converters connected in parallel. This connection works well when the distributed resistances (R_{DISTR}) range between 20 and 40 mΩ. The converters will typically share the load current in a 3:2 ratio, with a worst-case ratio of 2:1.

The supervisory circuits measure the input currents

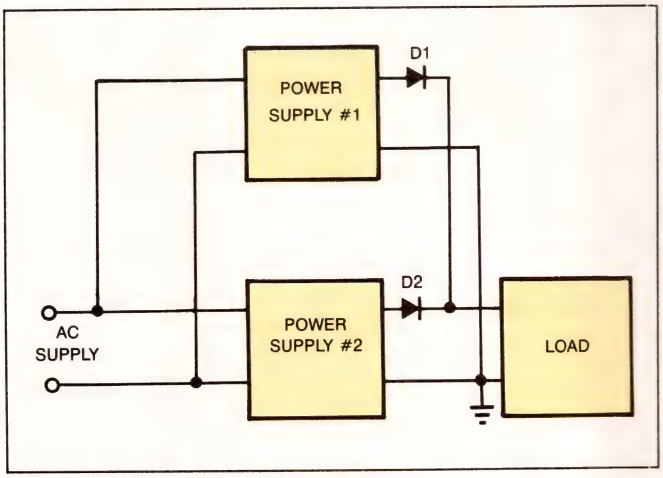


*Fig 4—**Doubling up on the power supplies yields redundancy** in this configuration. The ORing diodes are required because the supplies' output circuits contain weak-link components (electrolytic capacitors).*

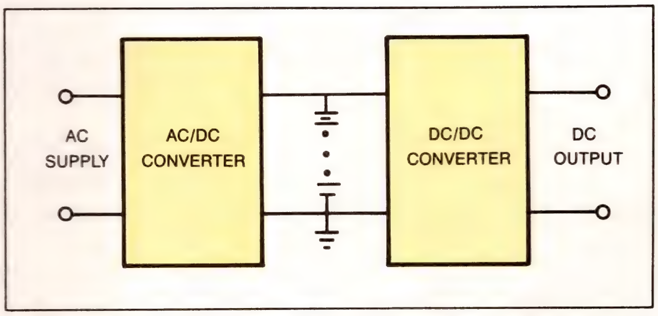


*Fig 5—**A more reliable UPS structure** eliminates the dual power-conversion circuitry seen in **Fig 4.** This architecture eliminates the need for large electrolytic capacitors that would otherwise be required for hold-up purposes.*

The down time attributable to power-conversion faults can be four times the down time arising from interruptions in the main ac supply.

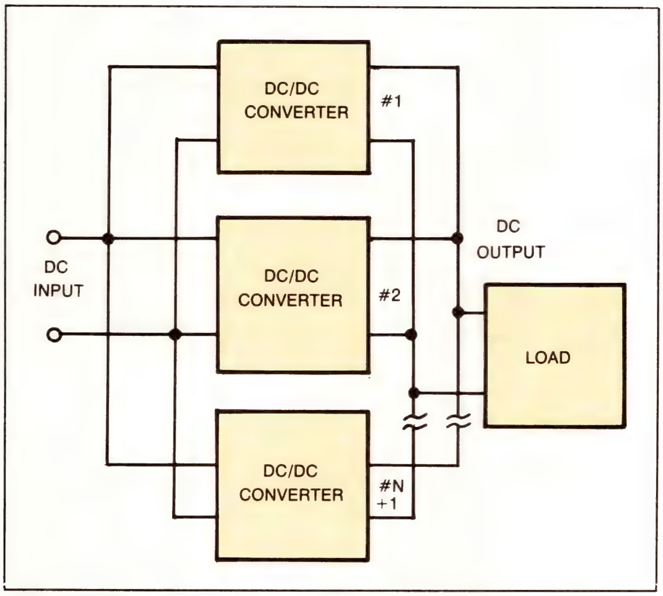


Fig 6—A redundant system built with parallel dc/dc converters *connects directly to the load without the need for ORing diodes. This is a reliable configuration, thanks to the use of small ceramic filter capacitors in the converters' outputs.*

drawn by each of the converters. A 100-mΩ sampling resistor converts the current value to a voltage at the output of the op amp in each of the circuits. The highest current value determines the bus voltage applied to each supervisory circuit. The supervisory circuit compares each converter's individually measured current value with the largest current value. If a supervisory circuit senses a current ratio that's greater than 6:1, the corresponding relay closes. This closure provides an alarm signal that indicates a fault condition in the respective converter.

To ensure that the converters share the load current equitably, you can use an active current-sharing scheme (**Fig 8**). This scheme takes advantage of an output-voltage adjustment pin available on the PKA Series of dc/dc converters. Each converter has two regulation loops. One of these loops senses the output current of the respective converter through a 20-mΩ sampling resistor. The highest current value sets the reference voltage on the output bus. This voltage is distributed as a reference value to the individual regulation loops. Each of the regulation loops compares the

Weak links limit UPS reliability

The overall reliability of a power supply is determined by the weakest parts in the system. In a UPS, these parts are the inverter and the succeeding ac/dc power supply, because both these blocks use electrolytic capacitors for filtering. You can obtain representative reliability figures for a 2-subpart (for example, inverter and power supply) UPS by using specified MTTR and MTBF figures:

$$U = \frac{\text{MTTR}}{\text{MTBF}}$$

$$A = \frac{\text{MTBF} - \text{MTTR}}{\text{MTBF}} = 1 - U$$

$$t_{\text{DOWN}} = U \cdot 8760 \text{ hrs}$$

$$A_S = A_1 \cdot A_2$$

$$= (1 - U_1)(1 - U_2)$$

$$A_S = 1 - (U_1 + U_2)$$

(neglecting $U_1 \cdot U_2$),

where A is the operational availability of a subpart of the system, U is the unavailability, t_{DOWN} is the accumulated down time (for example, 1 year), and A_S is the system availability.

Typical reliability figures for a UPS's inverter and switching power supply (SPS) are:

MTBF_{UPS}=50,000 hours (inverter)
MTBF_{SPS}=50,000 hours (supply)
MTTR=48 hours (either unit)

The overall system availability (A_S) is dependent on the availability of these two devices:

$$A_S = 1 - \frac{(48 + 48)}{50{,}000}$$

$$= 0.9981 = 99.81\%.$$

This figure does not include the unavailability of the main ac supply. A practical figure for the unavailability of the main supply is $U_M = 4.57 \times 10^{-4}$. Taking this value into account, the overall availability is

$$A_{\text{TOTAL}} = 0.9981 - 0.000457$$
$$= 0.9976 \text{ (99.76\%), and}$$

$$t_{\text{DOWN}} = (1 - A_{\text{TOTAL}}) \times 8760 \text{ hours}$$
$$= 21 \text{ hours.}$$

If you compare the unavailability of the main ac supply (0.0457%) with the unavailability of the UPS system ($U_{\text{SYS}} = 1 - 0.9981 = 0.0019$ or 0.19%), the unavailability (the time of unavailability of secondary power) caused by the backup system is more than four times greater than that attributable to the main ac supply.

reference value with individually sensed output-current values.

The second loop senses the distributed voltage and compares it with that of a stable reference diode. The outputs of the two regulation loops are connected in parallel and sent to the voltage-adjust pin on each dc/dc converter. If either the sensed value of the output current or the sensed distributed voltage differs from its respective reference value, the control loop adjusts the voltage of the appropriate dc/dc converter to balance the load distribution.

Each converter has a supervisory circuit for its input

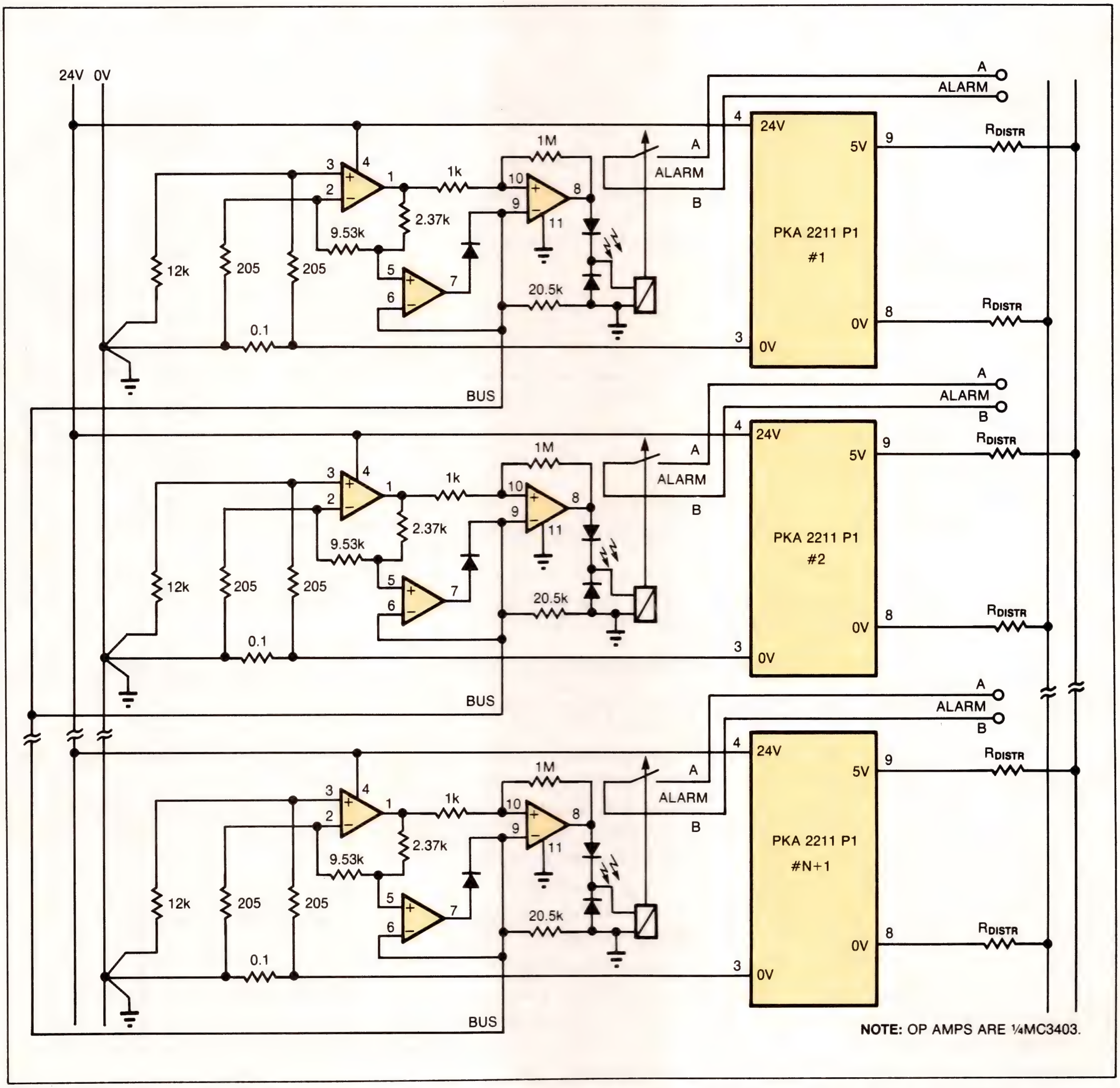
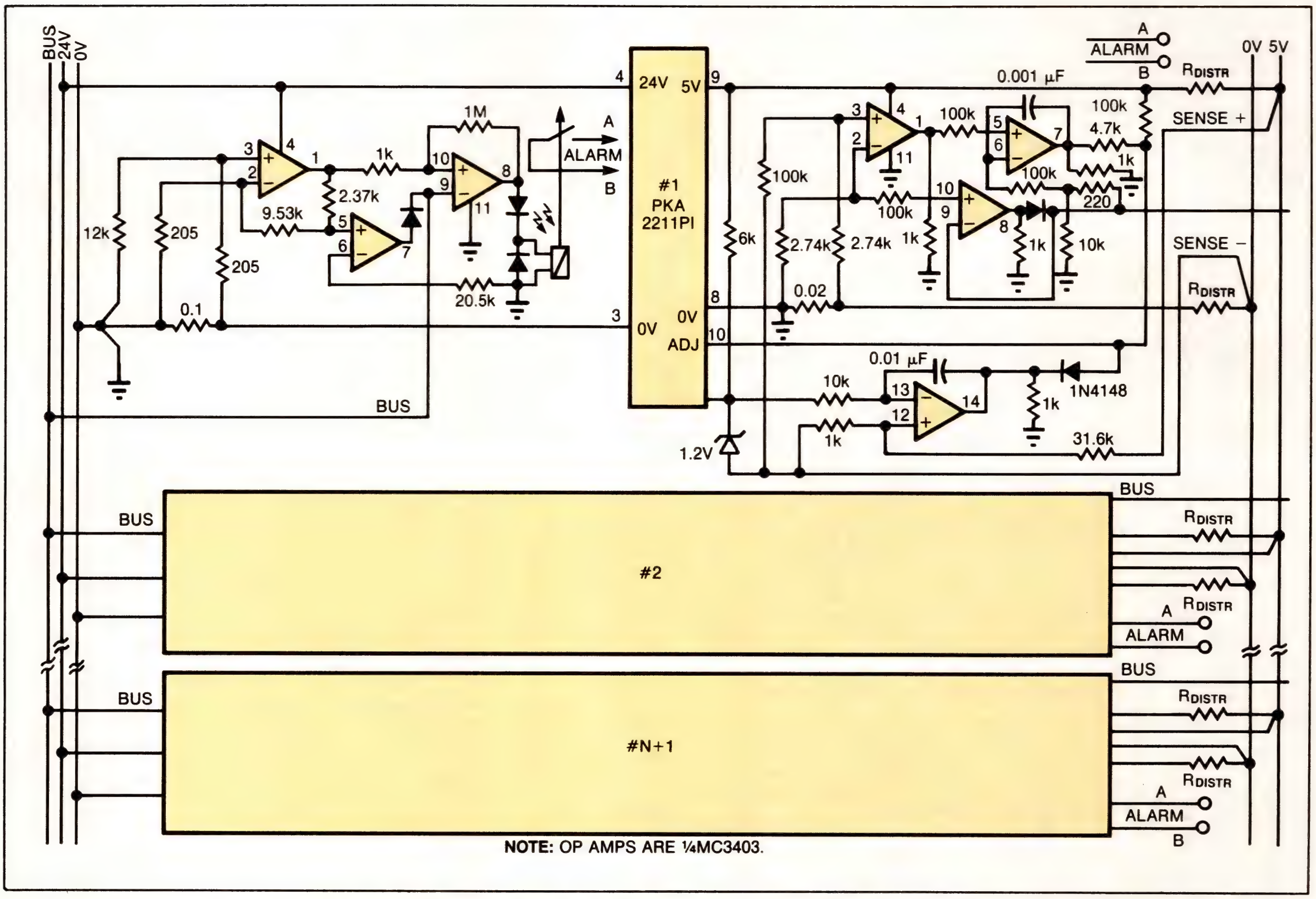


*Fig 7—**Supervisory circuits sense the input currents to the dc/dc converters** and trigger an alarm when a fault is detected. The converters in this configuration typically share the load current in a 3:2 ratio. If a ratio exceeds 6:1, an alarm indicates a fault condition in the appropriate converter.*



NOTE: OP AMPS ARE ¼MC3403.

*Fig 8—**Current-sensing circuitry on the outputs of the dc/dc converters** provides an equitable sharing of the load current. This configuration balances the load requirements for the converters to within 5%.*

Converter switching frequencies creep upward

When switch-mode dc/dc converters were introduced in the '60s, the switching frequency was typically lower than 20 kHz. As magnetic components having lower high-frequency switching losses developed, the converters' operating frequencies increased. Today, dc/dc converters using bipolar transistors operate optimally in the 40- to 75-kHz range.

Another milestone was reached with the advent of power MOSFETs. It became possible to build efficient dc/dc converters that use switching frequencies of a few hundred kilohertz (for example, the PKA Series operates with a 300-kHz switching frequency). The trend to higher frequencies has many advantages. Higher-frequency operation has made it possible to use smaller magnetic components. Therefore, the dc/dc converter has become a device that can be mounted on a pc card.

High-frequency switching also makes it possible to use smaller and more reliable capacitors to reduce the ripple on the dc lines. The PKA Series uses full-wave rectification, which produces a ripple-frequency component of 600 kHz. A small ceramic capacitor in the range of 1 µF provides adequate filtering. The elimination of electrolytic capacitors greatly increases a converter's reliability. In addition, the low capacitance value reduces the duration and peak value of the inrush current.

current. This supervisory circuit triggers an alarm circuit similar to the one in **Fig 7.** The current-sharing scheme can balance the load requirements for the dc/dc converters to within 5%. Consequently, the units are never overstressed, and never operate at their maximum rated output power. This low-stess environment naturally enhances the converters' reliability.

When dc/dc converters are connected in parallel, the only factor that affects the overall operation is a failure in the output circuitry of a converter. Therefore, the reliability of the output circuitry of the converters is the sole contributor to the overall reliability figure. The MTBF of the output circuitry in the PKA Series of dc/dc converters is 4500 years. Therefore, the overall reliability figure is

MTBF=4500 years÷(number of converters in parallel)

If the overall MTBF figure determined by this expression is not adequate, then you can connect the outputs of the dc/dc converters through ORing diodes. However, the remote-sensing circuits must then compensate for the voltage drops across the diodes.

Efficiencies of about 65% are achievable from parallel-connected dc/dc converters that don't use the ORing diodes. This number compares favorably with the typical 40% efficiency of a conventional UPS. **EDN**

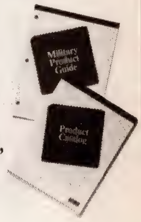
Author's biography

Lars Thorsell is product marketing manager for Rifa Power Products in Stockholm, Sweden. After receiving a BSEE from the Stockholm Tekniska Institute in 1969, he designed power supplies and power systems in the power-supply department at Ericsson for nine years. He then gained four years of experience in the semiconductor industry while working as an applications engineer and product marketing manager at SGS Scandinavia AB. Before joining Rifa, Thorsell served as product manager and marketing manager for Ulceco Power Products.

Article Interest Quotient (Circle One)
High 485 Medium 486 Low 487

MIL-STD-883C COMPLIANT

For math-intensive processing, Logic Devices offers a whole range of innovative *architectural solutions,* including these low-power CMOS functions. So if your application is pushing data rates of 25MHz and beyond, check out our real-time solutions. Call toll free 1-800-851-0767 (in California, 1-800-233-2518) for a product catalog, which includes our MIL-STD-883C compliant parts. Or write: Logic Devices, Inc., 628 East Evelyn Avenue, Sunnyvale, California 94086. Telex 172387.



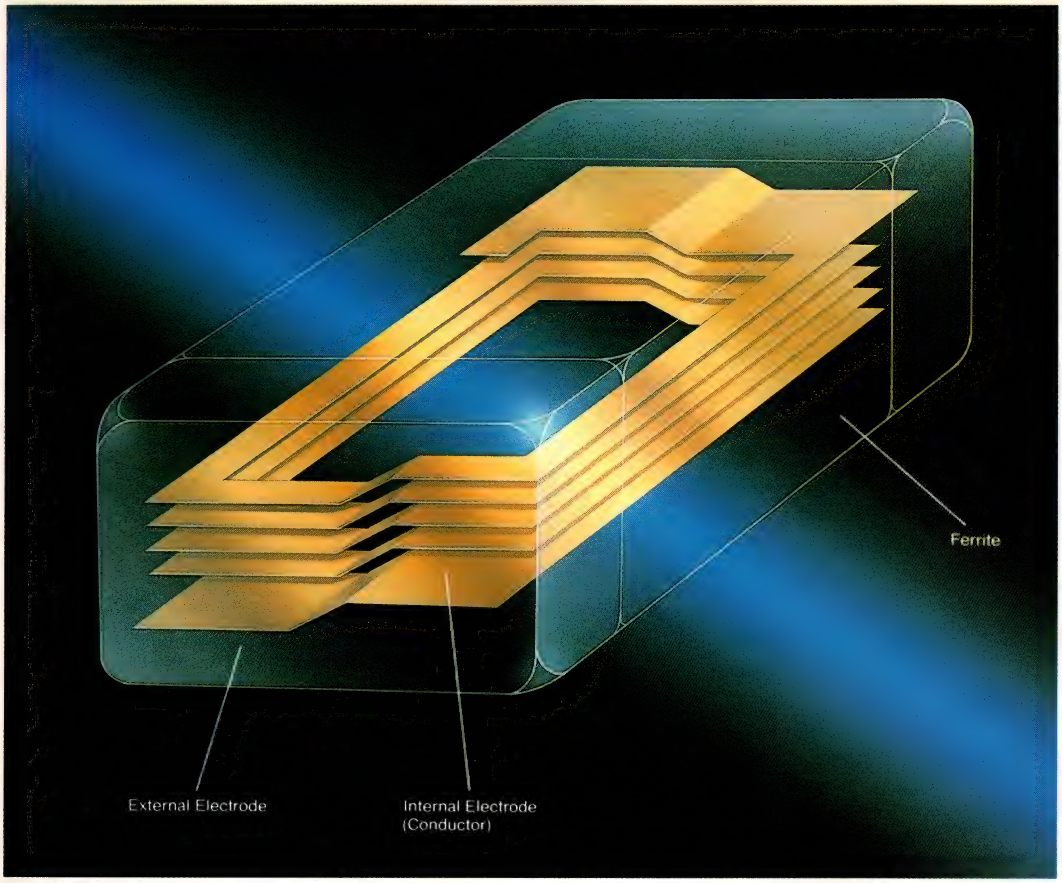
16-bit ALU L4C381
- 16-bit cascadable ALU, with 26ns. flow-through add time.
- Includes optional pipeline registers.
- Implements add, subtract, accumulate, two's complement, pass and logic operations.

16-bit multiplier LMU18
- 16x16 multiplier, with 35ns. multiply time.
- Non-multiplexed 32-bit output port.

32-bit barrel shifter/normalizer LSH32
- 32-input, parallel shifter with 32ns. prop. delay.
- Implements left, right, or circular shifts, 0 to 32 positions; automatically calculates optimum scaling value for maximum accuracy.
- Separate external shift distance inputs for block floating-point applications.

12-bit multiplier-summer (AxB)+C LMS12
- 12x12 multiplier, plus 26-bit adder in one package.
- Cascadable to form 25MHz video filter with broadside coefficient load.

LOGIC
DEVICES INCORPORATED **CIRCLE NO 16**



TDK Multilayer and Integration Technology Stands at the Leading Edge with TDK Multilayer Chip Inductors.

For the first time ever, inductors can be made without actual winding. Consider TDK Multilayer Chip Inductors. Thanks to TDK, they eliminate the problems of high density circuit boards.

Multilayer surface mount devices from TDK include ceramic chip capacitor networks, chip band pass filters and chip LC traps that require both designs and manufacturing technology of a sophisticated nature. Furthermore, TDK is making significant progress toward "super multilayer" and high circuits integration.

TDK technology ranges from raw materials to finished multilayer chip components to automatic mounting equipment, namely, our Avimount series. We strive to meet the requirements of the industry for high quality, high performance chip components. And we're striving to achieve total surface mount technology from start to finish.

When it comes to SMT, come to TDK.

See our Surface Mount Devices and other fine Products at Electro/88, Boston, May 10-12, TDK Booth No. 1065.

Electro/88

TDK Surface Mount Technology—At Your Service.

TDK®

TDK CORPORATION OF AMERICA HEAD OFFICE 1600 Feehanville Drive, Mount Prospect, IL 60056, U.S.A. Phone: (312) 803-6100 CHICAGO REGIONAL OFFICE Phone: (312) 803-6100 INDIANAPOLIS REGIONAL OFFICE Phone: (317) 872-0370 NEW YORK REGIONAL OFFICE Phone: (516) 625-0100 LOS ANGELES REGIONAL OFFICE Phone: (213) 539-6631 DETROIT DISTRICT OFFICE Phone: (313) 353-9393 NEW JERSEY DISTRICT OFFICE Phone: (201) 736-0023 HUNTSVILLE DISTRICT OFFICE Phone: (205) 539-4551 GREENSBORO DISTRICT OFFICE Phone: (919) 292-0012 DALLAS DISTRICT OFFICE Phone: (214) 506-9800 SAN FRANCISCO DISTRICT OFFICE Phone: (408) 437-9585 **TDK CORPORATION.** TOKYO, JAPAN.

Simplifying High Density Placement TDK Surface Mount Devices

Multilayer Ceramic Chip Capacitor

C1608 (CC0603)
C: 0.5~22,000pF
C2012 (CC0805)
C: 0.5~100,000pF
C3216 (CC1206)
C: 0.5~220,000pF
C3225 (CC1210)
C: 750~470,000pF
C4532 (CC1812)
C: 2,400pF~1μF
C5650 (CC2220)
C: 5,100pF~1.5μF

Multilayer Chip Capacitor Network

MCN7575
TC: CH, 1~100pF
(10 capacitors)
SL, 10~1,000pF
(10 capacitors)
Class II,
100~470,000pF
(10 capacitors)

Multilayer Ceramic Chip Capacitor (High Frequency, Low Loss)

FC1414
C: 0.5~3,300pF
FC2828
C: 0.5~22,000pF
FR1414
C: 0.5~3,300pF
FR2828
C: 0.5~22,000pF

Multilayer Chip Inductor

MLF2012
L: 0.047~33μH
MLF3216
L: 0.047~33μH
MLF3225
L: 39~220μH

Multilayer Chip LC Trap

MXT4532
F: fo ±2%

Multilayer Chip IFT

MIA4532
F: 455, 459, 464kHz
MIF4532
F: 10.7MHz

Multilayer Chip Transformer

MTT4532
L: 10~200μH

Multilayer Chip LC Filter

MXF4532H
HPF (Tuner)
MXF4532B
BPF (FM radio)
MXB5050B
BPF (VCR)
MXB5050L
LPF (VCR)
MXB5050D
Delay Line (VCR)
A variety of characteristics are available.
Please specify when ordering.

Leadless Inductor (Wound Chip Inductor)

NL322522
L: 0.01~220μH
NL453232
L: 1.0~1,000μH
NL565050
L: 1,200~10,000μH
NLF453232
L: 1.0~1,000μH
(Shielded Inductor)

Leadless LC Trap (Wound Chip LC Trap)

NLT4532
F: 630kHz~13MHz
Tolerance: ±2%
Attenuation: 20dB min.

Leadless EMI Filter (Wound Chip EMI Filter)

NLL4532
C: 33pF~100,000pF
L: 1μH~220μH

Ferrite Chip Bead

CB201209
Zo: 7, 10, 11Ω
CB321611
Zo: 19, 26, 31Ω
CB322513
Zo: 31, 52, 60Ω
CB453215
Zo: 70, 120, 125Ω

NTC Chip Thermistor

NTC CS3216
R typical:
1.0~150kΩ at 25°C
Temp. Range:
−25 to +85°C

SM Active Delay Line

FDL
Delay time:
20~75 nsec.

SM Transformer/ Inductor

EE5 **ER9.5**
EE12 **ER11**
T2 **ER14.5**
A variety of characteristics are available.
Please specify when ordering.

SM Step-up Inductor (Piezoelectric Buzzer)

OL3.3 x 1.6
OL3.3 x 2.1
Inductance values are representative, please specify value when ordering.

CIRCLE NO 204

Plug-in power for VME!

Here's a fully featured 400-watt, triple-output power system that's configured for *direct connection* to the motherboard in your VME bus system. It's a standard MOSFET switcher that includes all the features you've come to expect from NCR Power Systems.

Switching frequency is 80 kHz, and the unit has protection against overvoltage, overcurrent, and input surges. It meets the stringent safety and EMI requirements established by UL, CSA and TUV (VDE). Packaging complies with the Eurocard standards defined in DIN-41494 and IEC-297 for plug-in attachment to the motherboard. Precise (±0.4%) line and load regulation and 75% efficiency make the unit ideal for data communications and processing applications.

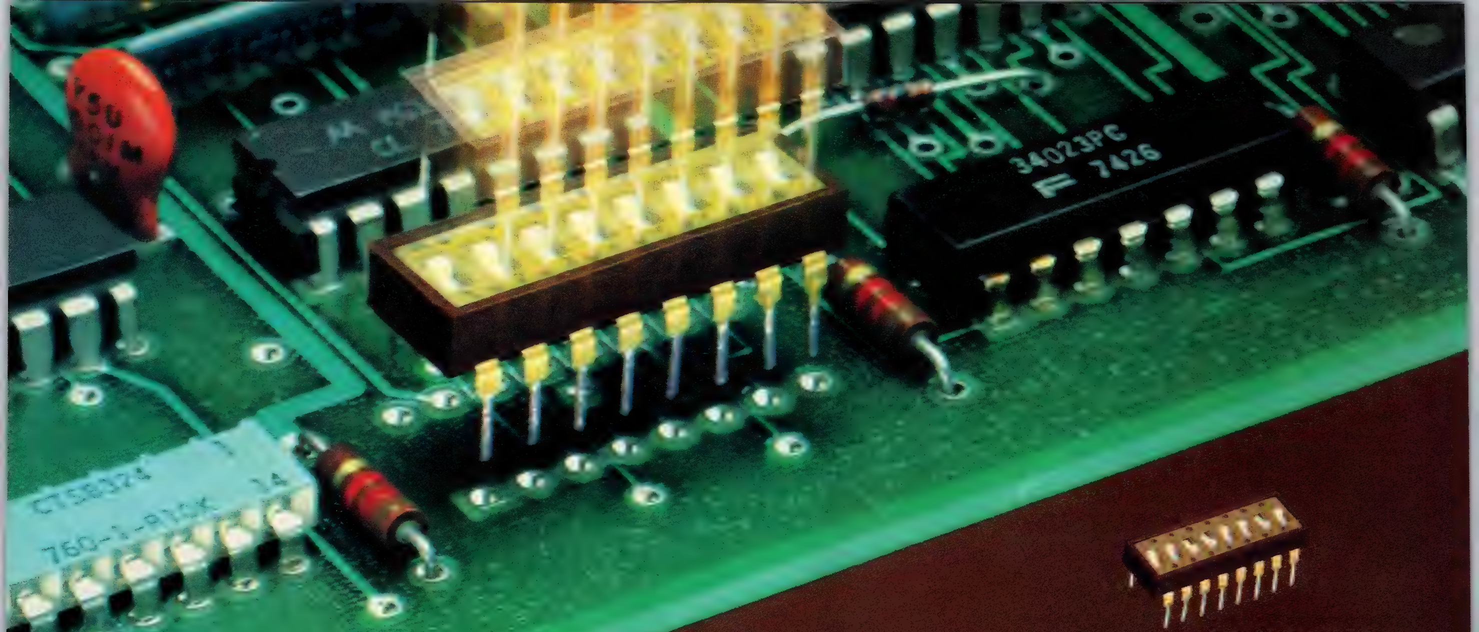
Standard units can be modified by NCR for precise conformance to customer requirements.

For detailed specifications and price quotation, contact NCR Power Systems, 3200 Lake Emma Road, Lake Mary, FL 32746-3393; Telephone 800/327-7612 or in Florida, call 407/323-9250.

NCR

See us at ELECTRO, Booths 1362 & 1364

CIRCLE NO 203



Actual size switch

New! CTS AUTO-DIP™ Switches for

AUTOMATIC INSERTION!

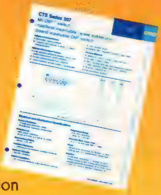
You'll realize immediate cost savings in board production with the New CTS Series 207 AUTO-DIP™ Switch.

Because they are the same size as your IC's—these new Series 207 AUTO-DIP™ switches can be used in your automatic insertion equipment right along with IC's...without machine adjustment. You get economical high speed board production. You'll save significant board space as well! This new switch takes only 37% of the volume of a standard DIP switch allowing for closer board stacking and space savings.

Wave solderable! Board washable! The AUTO-DIP™ design eliminates bottom sealing. And, a lead frame housing construction with time-proven tape top seal keeps contaminants out of the switch through wave soldering and solvent or aqueous cleaning.

Reliability you can count on. During the fully automated assembly process, each Series 207 DIP Switch is 100% machine tested for continuity and contact resistance. In addition, statistical process control used in every step during manufacturing assures unvarying part quality and final reliability. Available in 2-position to 12-position switches.

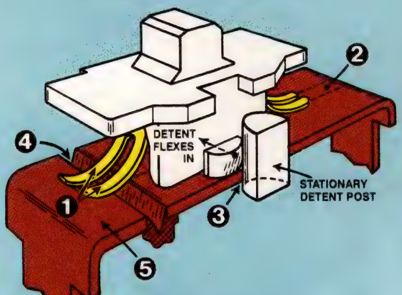
WRITE TODAY for full technical data on these new Series 207 AUTO-DIP™ switches.



Contact: CTS Corporation,*
Paso Robles Division,
Electromechanical Group,
500 Linne Road,
Paso Robles, CA 93446.
Phone: (805) 239-0427

*In Calif. dba CTS Electronics Corporation

Switch reliability that is the best ever!



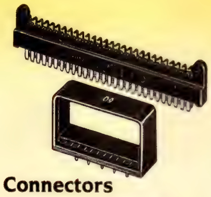
1. Redundant gold inlaid contacts dramatically enhance contact reliability.
2. Positive wiping contacts assure low and consistent contact resistance. (.050″ travel)
3. Detent function separated from contacts to optimize both designs.
4. Gold contacts never abraded or contaminated by sliding over polymer surfaces. Contacts never touch a nongold surface
5. No contactor deflection for the life of the switch. Constant contact force eliminates overstressing of contacts for greater reliability.

CTS means Reliability

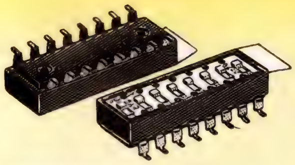
CTS CORPORATION • ELKHART, INDIANA

Call TOLL FREE 1-800-982-0030
for name and location of nearest CTS Sales Engineer

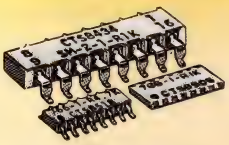
Series CCXO-140 Leadless chip carrier crystal oscillator for surface mounting
Phone: (815) 786-8411
CIRCLE NO 198



Connectors
Custom PC board and military styles.
Phone: (612) 533-3533
CIRCLE NO 199



Surface Mount AUTO-DIP® Switches Process compatible. Series SM 207.
Phone: (805) 238-0350
CIRCLE NO 200



Surface Mount Resistor Networks Numerous package configurations and attachment choices.
Phone: (219) 589-8220
CIRCLE NO 201

The first good reason in 5 years to buy new 8-bit development tools.

SPECIFICATIONS

- Emulation at fully rated clock speeds of CPUs.
- Less than 5 ns signal skew at probe tip.
- Full use of all interrupts and memory.
- Advanced real time events qualified by address/range, data, status, delay/pass counts.
- Control of state transitions from event to event.
- Two complex input and two complex output triggers.
- 64K to 1 M of real time address breakpoints qualified as read, write, or either read/write.
- Full symbolic debug.
- EL-800 supports 64180, Z80H. EC-7000 supports 8051 and 68HC11 families. EM supports 8080, 8085, 8048 family, 6800/2/8, 6809/E, Z80, MK3880 and NSC-800.

We asked design engineers to describe the ideal 8-bit development system. Then we designed it.

Introducing the EL-800: real-time transparent emulation, the most powerful event system available plus lots of trace memory…all for under $5000.

The second good reason.

The EL-800's triggers and breakpoints let you quickly identify complex bugs. Our powerful Advanced Event System controls emulation with a combination of address, data, status, counters and logic fields. And you can specify up to 1 Megabyte of overlay memory.

But we didn't stop there.

The EL-800 also comes with symbolic debug as well as a quick and easy way to define up to 1 million breakpoints. And it provides closely coupled interfaces to high level debuggers…all for much less than you'd expect to pay for an Applied Microsystems emulator.

What's more, the new modular design makes it easy to add additional capabilities and new processors without switching to a new operating environment or discarding your emulator.

Ask us about our plans to develop a library of options for the EL-800, performance analysis, post processing of real-time trace, and software development tools. And let us show how we can extend support to your particular 8-bit microprocessor or microcontroller.

To find out more, call 1-800-426-3925 (in WA, 206-882-2000). Or mail us the coupon below.

Applied Microsystems Corporation, P.O. Box 97002, Redmond, WA 98073-9702

To learn more about the new EL-800 emulator, I'd like to receive:

☐ Free literature ☐ A free demonstration ☐ A free demo disk
☐ Free application note on cross-triggering with 8- and 16-bit emulators
☐ Free 10 day evaluation

Name________________________________

Title________________________________

Company____________________ Phone__________

Address________________________________

City______________ State________ Zip________

EDN 042888

Applied
Microsystems
Corporation

CIRCLE NO 202

SHHHHHH.

1 nV/$\sqrt{Hz}$ OP AMP AT WORK.

Quiet Please.

Introducing the LT1028, our new ultra-low noise, precision, high-speed op amp that combines unprecedented low-noise voltage with high-speed and precision DC specifications.

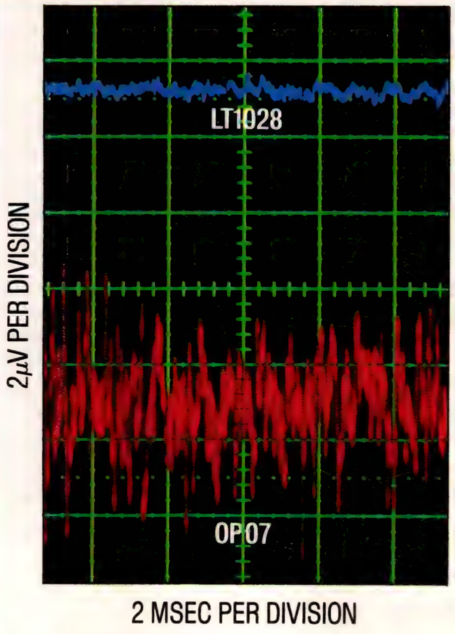
The LT1028's wideband noise density is 0.85 nV/$\sqrt{Hz}$, *less than the noise of a 50Ω resistor.* The LT1028 is three times better than the previous leaders (our own LT1007 and LT1037). Even at 10Hz, voltage noise only rises to a mere 1.0nV/$\sqrt{Hz}$. Further, we 100% test voltage and current noise, and guarantee 1 kHz voltage noise at 1.1nV/$\sqrt{Hz}$ maximum.

Slew rate is guaranteed at 11V/µsec, and gain-bandwidth at 50 MHz.

The LT1028 also excels in DC specs: 40µV maximum offset voltage, and 0.8µV/°C maximum drift. Voltage gain is guaranteed at 7 million, *the highest of any op amp.* This high gain, combined with the wide bandwidth, means that a gain in excess of 3 million can be achieved up to 30 Hz. Compare this to other "million-gain" op amps where the gain falls below 3 million above 0.2 Hz, if the signal processed changes faster than once every five seconds.

Typical applications for this ultra-low noise op amp include low-noise frequency synthesizers and phase-lock loops, high-quality audio, accelerometer and gyro amplifiers, infrared detectors, magnetic search coil and hydrophone amplifiers. Even in low source impedance transducer or audio amplifier applications, the LT1028's contribution to total system noise is negligible.

If you're ready to enter *The Quiet Zone,* ask about our LT1028 (or our LT1037 and LT1007 op amps). Pricing for the LT1028 family starts at $4.95 for the LT1028CN8 (in quantities of 100). This device is available in commercial and military temperature ranges and meets MIL-STD-883 specifications. For details, contact: LINEAR TECHNOLOGY CORPORATION, 1630 McCarthy Blvd., Milpitas, CA 95035. **800-637-5545.**



The LT1028 is 12-times less noisy than the OP07, the standard for low-noise op amps.

LINEAR TECHNOLOGY

TOUGH PRODUCTS
FOR TOUGH APPLICATIONS.

CIRCLE NO 197

DESIGN IDEAS

EDITED BY TARLTON FLEMING

Electronic thermometer has 10-mV/°F output

Bill Donofrio and Dennis R Bernard
Moore Research Ctr, Grand Island, NY

Using type-K thermocouple wire, you can build an inexpensive electronic thermometer that generates 10 mV/°F (**Fig 1**). Because type-K thermocouples are reasonably linear for the range of 0 to 660°C, you can obtain a moderately accurate temperature measurement for this range by adding a scaling voltage to the cold-junction reference voltage.

The 9V battery powers a bridge circuit in which the temperature sensor, IC_2, and the 2.5V reference, IC_3, provide a signal and reference voltage, respectively. You should place the cold-junction thermocouple close to the temperature sensor. Note that the chromel wires form secondary junctions where they attach to the circuit (nodes A and B). To avoid introducing dc errors, you should maintain these junctions at the same temperature by placing them close together. Bypass capacitors C_6 and C_7 guard against errors due to RF pickup.

Potentiometer R_5 produces a temperature-dependent scaling voltage, and the chopper-stabilized op amp, IC_1, amplifies (with a gain of 1001) the sum of the scaling and thermocouple voltages. As a result, the output V_T equals the sum of the thermocouple cold-junction voltage plus the scaling voltage (0.744 mV), divided by 0.0226. Potentiometer R_6 determines the 0.0226 figure.

To calibrate the circuit, first adjust R_4 for 2.554V across IC_3. Then adjust R_3 so the voltage across IC_2 equals 10 mV times the ambient temperature (in °K). Place the hot-junction thermocouple in a well-stirred mixture of crushed ice and water, and adjust R_5 so that the op-amp output (across R_6) equals 0.744V. To complete the calibration, adjust V_T to 0.32V using R_6. **EDN**

To Vote For This Design, Circle No 748

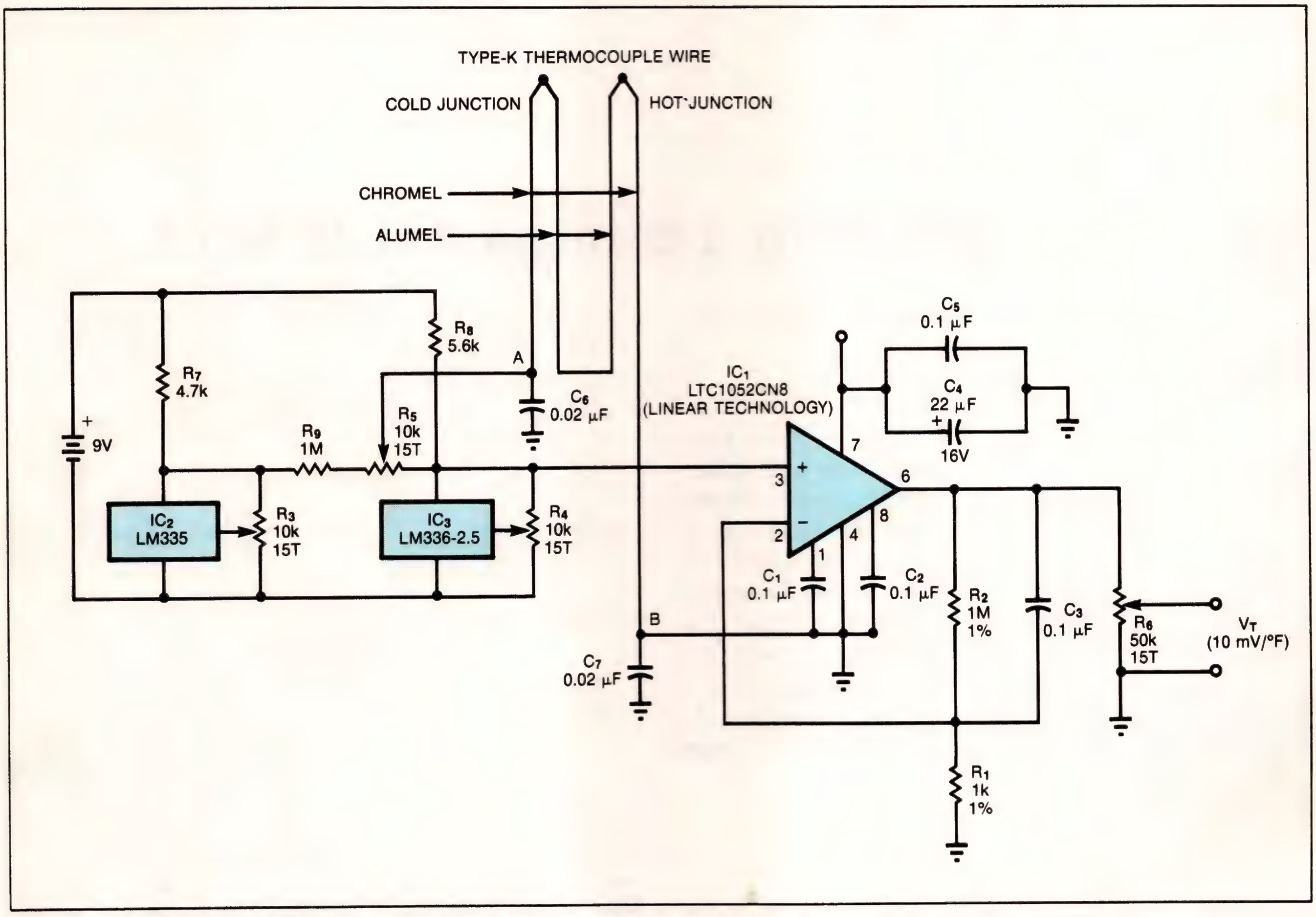


***Fig 1—This circuit adds a linearizing voltage** to the thermocouple voltage and produces an output V_T of 10 mV/°F.*

Add two 16-bit pointers to the 8031 μP

Noor Singh Khalsa
EG&G Inc, Los Alamos, NM

Although Intel's 8031 μP has only one 16-bit pointer (DPTR), the device's page-mode addressing feature allows you to add two more. The 8031 restores any value on the P2 output port (the upper address byte) following each instruction fetch, so you can use the R0 and R1 registers for indirectly addressing memory in the current "page" selected by P2:

```
MOVX    A,@R0
MOVX    A,@R1
```

By dedicating two other registers (such as R6 and R7) for the upper address byte, you can form two 16-bit pointers, R6,R0 and R7,R1, for use in accessing the external memory (**Table 1**). This technique does not affect the DPTR, so you can avoid the code space otherwise needed to save the 2-byte DPTR (two push instructions and two pop instructions). Because a subroutine call or an MOVX A, @DPTR instruction will modify the P2 value following an instruction fetch, you mustn't execute these instructions without restoring the P2 pointer value. **EDN**

TABLE 1—BLOCK-MOVE ROUTINE

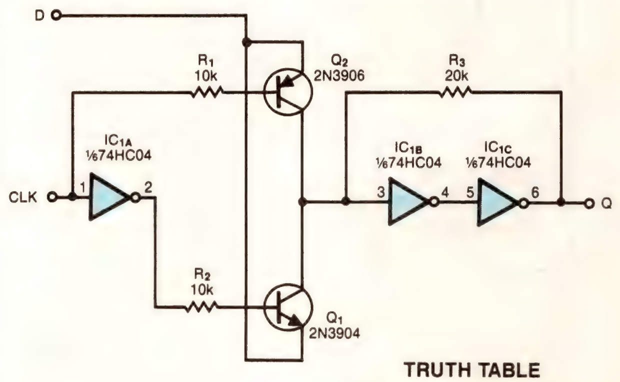
```
BLKMOVE: MOV    P2,R6           ; SELECT PAGE OF MEMORY
                                ; TO ACCESS
         MOVX   A,@R0           ; READ BYTE AT R6,R0
         MOV    P2,R7           ; CHANGE PAGE
         MOVX   @               ; STORE BYTE AT R7,R1
         INC    R0              ; INCREMENT SOURCE
                                  POINTER
         INC    R1              ; INCREMENT DESTINATION
                                  PTR
         DJNZ   R3,BLKMOVE      ; BYTE COUNT STORED IN R3
```

To Vote For This Design, Circle No 749

Spare inverters form a transparent D latch

Frank Gonzalez
General Instrument Corp, Hatboro, PA

Sometimes you can avoid adding an IC to a cost-conscious design by building a data latch with otherwise-unused inverter gates (**Fig 1**). The circuit latches the input data (D) on low-to-high clock transitions as shown in the truth table. Resistor R_3 produces the latching action by providing positive feedback around inverters IC_{1B} and IC_{1C}. Holding the CLK input low allows transparent operation: If the present state (Q_N) is low, D must be low, and Q_1 is on. A transition of D to the high level turns off Q_1 and turns on Q_2, providing the required high level at IC_{1B}'s input. **EDN**



TRUTH TABLE

CLK	D	Q_P	Q_N
↑	0	0	0
↑	0	1	0
↑	1	0	1
↑	1	1	1

Q_P = PRESENT STATE
Q_N = NEXT STATE

Fig 1—This transparent D latch operates *on the clock signal's rising edge. Operation is transparent when the CLK input is low.*

To Vote For This Design, Circle No 750

value-packed filters from $9.95

dc to 3GHz

- less than 1dB insertion loss over entire passband
- greater than 40dB stopband rejection
- 5 section, 30dB per octave roll-off
- VSWR less than 1.7 (typ)
- over 100 models, immediate delivery
- meets MIL-STD-202
- rugged hermetically sealed package (0.4 x 0.8 x 0.4 in.)
- BNC, Type N, SMA available

finding new ways ...
setting higher standards

Mini-Circuits
A Division of Scientific Components Corporation
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500
Fax (718) 332-4661 Domestic and International Telexes: 6852844 or 620156

LOW PASS Model	*LP- 10.7	21.4	30	50	70	100	150	200	300	450	550	600	750	850	1000
Min. Pass Band (MHz) DC to	10.7	22	32	48	60	98	140	190	270	400	520	580	700	780	900
Max, 20dB Stop Frequency (MHz)	19	32	47	70	90	147	210	290	410	580	750	840	1000	1100	1340

Prices (ea.): P $9.95 (6-49), B $24.95 (1-49), N $27.95 (1-49), S $26.95 (1-49)

HIGH PASS Model		*HP- 50	100	150	200	250	300	400	500	600	700	800	900	1000
Pass Band (MHz)	start, max.	41	90	133	185	225	290	395	500	600	700	780	910	1000
	end, min.	200	400	600	800	1200	1200	1600	1600	1600	1800	2000	2100	2200
Min. 20dB Stop Frequency (MHz)		26	55	95	116	150	190	290	365	460	520	570	660	720

Prices (ea.): P $12.95 (6-49), B $27.95 (1-49), N $30.95 (1-49), S $29.95 (1-49)

*Prefix P for pins, B for BNC, N for Type N, S for SMA *example:* **PLP-10.7**

C105 REV.D

CIRCLE NO 196

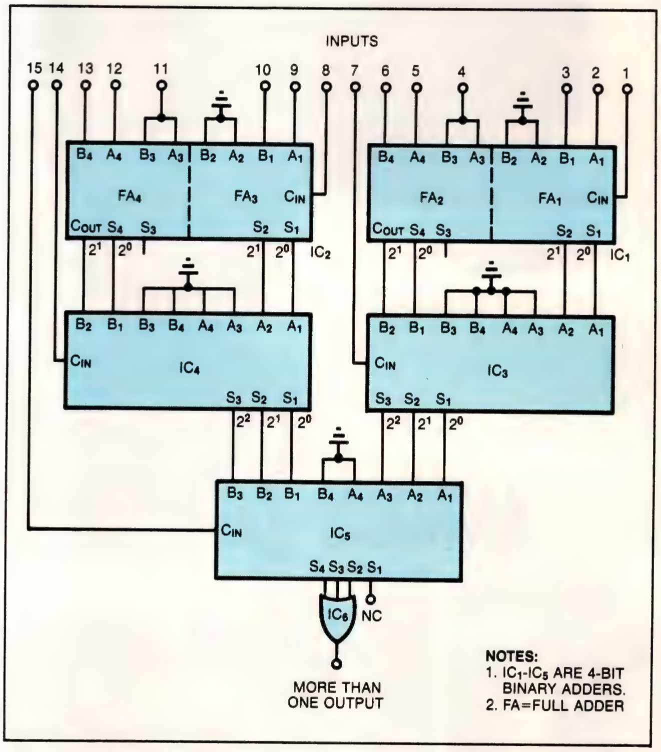
Adders enable detection of multiple inputs

S Murugesan
ISRO Satellite Centre, Bangalore, India

The **Fig 1** circuit determines whether more than one input in a group of digital inputs is active. It is simpler and more versatile than an earlier idea ("Tree structure detects multiple inputs," EDN, February 19, 1987, pg 195): It provides a digital measure of the number of active inputs, and it allows you to establish a threshold for majority-decision applications (that is, whether the number of active inputs is more than, less than, or equal to a value between 1 and 15). You can monitor more inputs by cascading the adders.

Each binary adder, IC_1 and IC_2, forms two full adders (FAs). Each FA monitors three input lines and generates a 2-bit output representing the number of inputs active. IC_3 and IC_4, by summing the outputs of two FAs plus an input line, individually measure how many in a group of seven inputs is active. Similarly, by monitoring the 3-bit outputs of IC_3 and IC_4 plus one input, IC_5 measures how many in the group of 15 are active. The OR gate (IC_6) simply indicates whether more than one input is active. **EDN**

To Vote For This Design, Circle No 746



NOTES:
1. IC_1-IC_5 ARE 4-BIT BINARY ADDERS.
2. FA=FULL ADDER

*Fig 1—**By counting in parallel, these binary adders** determine the number of active inputs among a group of 15. The OR gate indicates whether more than one is active.*

Program aids resistive-divider calculations

Hugh M Adams
Rtronics Inc, Pensacola, FL

Listing 1 helps you solve the general problem shown in **Fig 1**: how to determine the maximum possible value for V_2 and the minimum possible value for V_1, given the expected minimum and maximum values for V_1 and the values and percent tolerances for R_1, R_2, and R_3. **Fig 2** shows a typical application for this network. The goal in this case is to choose optimum resistor values that will set the voltage regulator's output within the specified limits of 4.5 to 5.5V.

The regulator, IC_1, includes a voltage reference

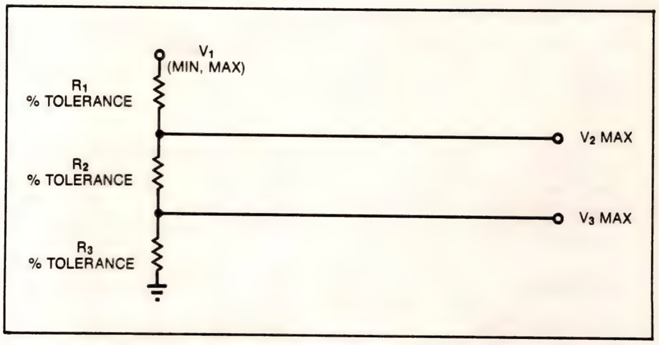


*Fig 1—**This circuit illustrates the general problem that Listing 1** solves. You provide the V_1 minimum and maximum inputs, plus a value and tolerance for each of the resistors.*

ZILOG

KILLER I/O

The Z84C90: Two serial, three parallel ports and a counter/timer on one chip. Just think what you can do with it.

Zilog's Z80 SPCT, Killer I/O,™ gives you a true "System on Silicon.™" With all the advantages of CMOS technology, Superintegration,™ and proven Z80 performance. Think of it as the door to a whole lot of new opportunities.

The Z80 Family: Still growing strong.

The Z80 remains the most commonly used 8-bit microprocessor in the industry. No wonder. As the family has continued to develop, so have the advantages: the familiarity of working with devices you know and trust, the tremendous value of being able to use software you've already developed, and, of course, there's the impressive Z80 performance.

As the Z80 Family has evolved through NMOS, CMOS, high-performance and high-integration, our commitment to Z80 has never wavered. New products have continued to be developed. Besides the 16-bit Z280 and the new Z84C90—the Killer I/O—there are a few more you really ought to look at:

▶*Z84C80/81*	*Z80-based systems GLU logic that can be used in every Z80 application*
▶*Z80180*	*the Z180 8-bit MPU combines a Z80 CPU, MMU, 2 UARTS, DMA, a C/T and more, with no extra logic needed for Z80 peripherals*
▶*Z84C01*	*combines a Z80 CPU with an on-board oscillator*

Lots of I/O.

You're simply not going to get more serial/parallel I/O anywhere. We've put together the most popular combination of discrete devices . . . two independent synch/asynch serial channels, two independent parallel ports, an 8-bit programmable port and four counter/timers. And, since they're all fully compatible with PIO, SIO and CTC devices, you have the advantage of "commonality."

Lots of performance.

Superintegration and CMOS technology mean the Z84C90 provides plenty of performance and flexibility. 8 MHz speed for instance. Plus you've got four independent counter/timers and on-chip oscillator to work with. And the peripherals can be used in any combination you need.

Lots of benefits.

You're designing with a highly integrated chip. And you're working with the familiar software and proven performance of the Z80 Family. That's enough to make the Killer I/O the best choice. But think about the lower cost you get from less real estate, lower manufacturing cost and reduced inventory. Think about improved time to market. Or the higher performance and reliability that come with super integration. And it's all off the shelf and backed by Zilog's proven quality.

So whether you're upgrading existing designs or looking for solutions in new applications like cellular phones, personal computers, industrial control, or data communications, you owe it to yourself to contact your local Zilog sales office or your authorized distributor today. Zilog, Inc., 210 Hacienda Ave., Campbell, CA 95008, (408) 370-8000.

Right product. Right price. Right away. **Zilog**

ZILOG SALES OFFICES: CA (408) 370-8120, (714) 838-7800, (818) 707-2160, **CO** (303) 494-2905, **FL** (813) 585-2533, **GA** (404) 923-8500, **IL** (312) 885-8080, **MA** (617) 273-4222, **MN** (612) 831-7611, **NJ** (201) 288-3737, **OH** (216) 447-1480, **PA** (215) 653-0230, **TX** (214) 231-9090, **CANADA** Toronto (416) 673-0634, **ENGLAND** Maidenhead (44) (628) 39200, **WEST GERMANY** Munich (49) (89) 612-6046, **JAPAN** Tokyo (81) (3) 587-0528, **HONG KONG** Kowloon (852) (3) 723-8979. **R.O.C.:** Taiwan (886) (2) 731-2420, **U.S. AND CANADA DISTRIBUTORS:** Anthem Electric, Bell Indus., Hall-Mark Elec., JAN Devices, Inc., Lionex Corp., Schweber Elec., Western Microtech., **CANADA** Future Elec., SEMAD.

CIRCLE NO 241

whose output (pin 6) can have any value from 6.95 to 7.35V. You must choose reasonable values and tolerances for resistors R_1-R_3. After receiving these eight data items, the program takes less than five seconds to calculate the resulting values for V_2 max and V_1 min. You continue to alter the inputs and rerun the program until it produces satisfactory outputs, a procedure that typically takes 5 to 10 minutes. (Note that an LM723 regulator's reference should not deliver more than 1 mA. For that device, you should double the resistor values to 1.36 kΩ, 2 kΩ (the potentiometer), and 4.3 or 4.4 kΩ.) **Listing 1** is written in HP Basic, but the program is also available in True Basic for the IBM PC.

To Vote For This Design, Circle No 747

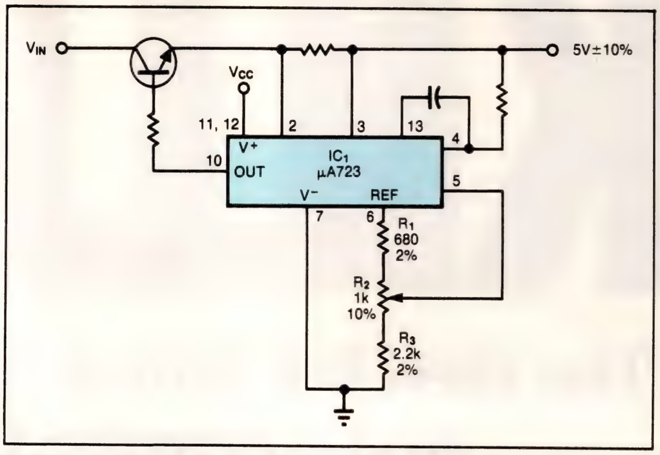


Fig 2—Using the Listing 1 program, *you can choose a combination of standard values and tolerances for resistors R_1-R_3 that will be nearly optimum for production.*

LISTING 1—RESISTIVE-DIVIDER PROGRAM

```
 10 CLEAR
 20 REM THREE RESISTOR DIVIDER PROGRAM
 30 OPTION BASE 1
 40 DISP "THIS PROGRAM AIDS IN SOLVING THE VOLTAGE DIVIDER PROBLEM"
 50 DISP "FOR A DIVIDER HAVING THREE RESISTORS AND TWO INPUT VOLTAGE."
 60 DISP
 70 DISP
 80 DISP "ENTER INPUT VOLTAGES V1MIN AND V1MAX";
 90 INPUT V1MIN,V1MAX
 100 DISP "ENTER R1,R1TOL(%)";
 110 INPUT R1,R1TOL
 120 DISP "ENTER R2,R2TOL(%)";
 130 INPUT R2,R2TOL
 140 DISP "ENTER R3,R3TOL(%)";
 150 INPUT R3,R3TOL
 160 DISP
 170 DISP
 180 R1L=R1*(1-R1TOL/100)
 190 R1H=R1*(1+R1TOL/100)
 200 R2L=R2*(1-R2TOL/100)
 210 R2H=R2*(1+R2TOL/100)
 220 R3L=R3*(1-R3TOL/100)
 230 R3H=R3*(1+R3TOL/100)
 240 DIM RM(8,3)
 250 MAT RM=ZER
 260 FOR W=1 TO 4
 270 RM(W,1)=R1L
 280 NEXT W
 290 FOR W=5 TO 8
 300 RM(W,1)=R1H
 310 NEXT W
 320 FOR W=1 TO 5 STEP 4
 330 RM(W,2)=R2L
 340 RM(W+1,2)=R2L
 350 NEXT W
```

Listing continued on pg 244

we never stop asking "What if..."

You shouldn't buy more board tester than you need.

Or less.

Now, you don't have to settle for too little or too much in a board tester. You can get one that's just right for you. From HP.

The HP 3065 family of board testers offers you flexibility. So you can get a system that fits your board mix, process, volume, and budget. Right now. And you can add capability or upgrade at any time to keep pace with your needs.

Our family begins with the HP 3065ST, our standard digital in-circuit tester starting under $100,000. And goes all the way to the HP 3065AT, one of the most advanced combinational testers on the market. You can combine controllers, test stations, and options for the exact system you need.

And no matter which you choose, you get software and fixture compatibility up and down the line. Networking with CAE/CAD workstations and simulators. Built-in analog functional instruments. A digital test library for 4,500 devices.

You get something else, too: HP experience in ATE dating back to 1975, with more than 85 service offices and 2,000 in-circuit testers installed worldwide. Plus, product reliability backed by our exclusive 99% Guaranteed Uptime Program.*

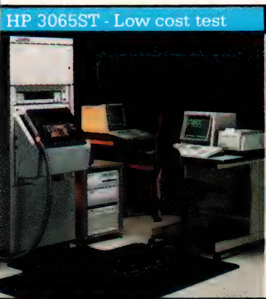
It all means better value for you. And, because our board test family offers systems at each level of price/performance, you buy just what you need . . . no more and no less.

Call HP today for a *free* videotape!

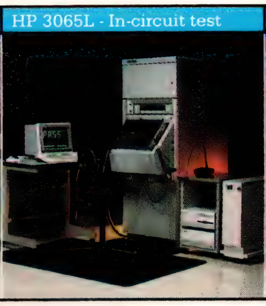
For a free videotape on the HP board test family, or more information, call 1-800-634-TEST (in Colorado, call collect: 303-669-9325.)

HEWLETT PACKARD

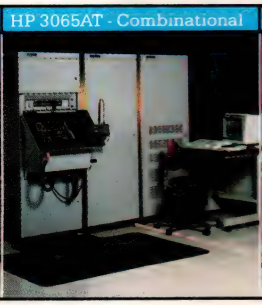
CIRCLE NO 195



HP 3065ST - Low cost test



HP 3065L - In-circuit test



HP 3065AT - Combinational

HP 3065AT - HP Telecomtest

*Some restrictions apply.

©1987 Hewlett-Packard Company 0901702

LISTING 1—RESISTIVE-DIVIDER PROGRAM *(Continued)*

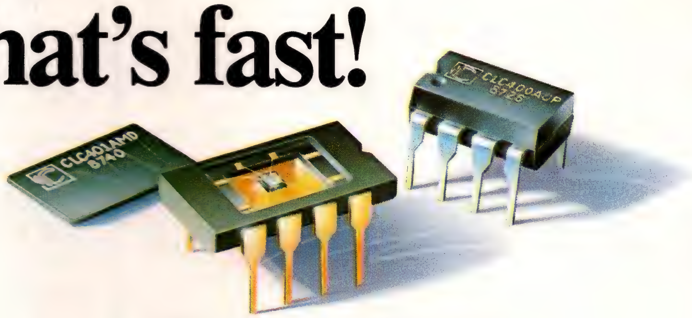
```
360 FOR W=3 TO 7 STEP 4
370 RM(W,2)=R2H
380 RM(W+1,2)=R2H
390 NEXT W
400 FOR W=1 TO 7 STEP 2
410 RM(W,3)=R3L
420 NEXT W
430 FOR W=2 TO 8 STEP 2
440 LET RM(W,3)=R3H
450 NEXT W
460 DIM V2A(8,2),V3A(8,2)
470 FOR J=1 TO 2
480 FOR I=1 TO 8
490 IF J=1 THEN V1=V1MIN
500 IF J=2 THEN V1=V1MAX
510 V2A(I,J)=V1*((RM(I,2)+RM(I,3))/(RM(I,1)+RM(I,2)+RM(I,3)))
520 V3A(I,J)=V1*(RM(I,3)/(RM(I,1)+RM(I,2)+RM(I,3)))
530 NEXT I
540 NEXT J
550 DISP "R1=";R1;R1TOL;"%";"R2=";R2;R2TOL;"%";"R3=";R3;R3TOL;"%"
560 DISP
570 DIM V2B(16),V3B(16)
580 W=0
590 FOR J=1 TO 2
600 FOR I=1 TO 8
610 W=1+W
620 V2B(W)=V2A(I,J)
630 V3B(W)=V3A(I,J)
640 NEXT I
650 NEXT J
660 FOR X=1 TO 15
670 LET SW=0
680 FOR K=16 TO X+1 STEP -1
690 IF V2B(K-1)<=V2B(K) THEN 740
700 SW=1
710 TM=V2B(K-1)
720 V2B(K-1)=V2B(K)
730 V2B(K)=TM
740 NEXT K
750 IF SW=0 THEN 770
760 NEXT X
770 DISP "V2MIN=";V2B(1)
780 FOR X=1 TO 15
790 SW=0
800 FOR K=16 TO X+1 STEP -1
810 IF V3B(K-1)<=V3B(K) THEN 860
820 SW=1
830 TM=V3B(K-1)
840 V3B(K-1)=V3B(K)
850 V3B(K)=TM
860 NEXT K
870 IF SW=0 THEN 890
880 NEXT X
890 DISP "V3MAX=";V3B(16)
900 END
```

Because you're thinking fast...

you need responsive suppliers as well as fast parts. Comlinear is tuned in. With high quality, high speed products. Assistance from R&D-level applications engineers to help develop your ideas quicker. Sales and distribution that get you what you need fast. Quality product documentation with guaranteed specs so you don't waste time. In your business, time is everything. Count on us for the speed you need.

Introducing monolithic op amps with 10ns settling times and 150-200MHz bandwidths.

That's fast!



Now, only from Comlinear, monolithic op amps with incredible high-speed, fast-settling performance.

Our new 200MHz CLC400 is designed for low-gain applications (±1 to ±8) and settles in a mere 10ns to 0.1%. For gains greater than 7, choose our 150MHz CLC401, with the same 10ns settling time. Both feature low power (150mW), low distortion, stability without compensation, plus overload and short circuit protection. They're ideal as flash A/D drivers and D/A current-to-voltage converters, or in video distribution and line driving applications.

Our experience in high speed amplifiers now brings you monolithic op amps with numbers like you've never had before. A new dimension in performance is now available for your analog designs.

Try one. Fast.

Comlinear Corporation

Solutions with speed

4800 Wheaton Drive
Fort Collins, Colorado 80525
(303)226-0500

© 1987 Comlinear Corporation

CIRCLE NO 193

Design Entry Blank

$75 Cash Award for all entries selected by editors. An additional $100 Cash Award for the winning design of each issue, determined by vote of readers. Additional $1500 Cash Award for annual Grand Prize Design, selected among biweekly winners by vote of editors.

To: Design Ideas Editor, EDN Magazine
Cahners Publishing Co
275 Washington St, Newton, MA 02158

I hereby submit my Design Ideas entry.

Name ______________________________

Title ____________________ Phone __________

Company ______________________________

Division (if any) ______________________________

Street ______________________________

City ____________ State ______ Zip __________

Design Title ______________________________

Home Address ______________________________

____

____

Social Security Number ____________________
(Must accompany all Design Ideas submitted by US authors)

Entry blank must accompany all entries. Design entered must be submitted exclusively to EDN, must be original with author(s), must not have been previously published (limited-distribution house organs excepted), and must have been constructed and tested.

Exclusive publishing rights remain with Cahners Publishing Co unless entry is returned to author or editor gives written permission for publication elsewhere.

In submitting my entry, I agree to abide by the rules of the Design Ideas Program.

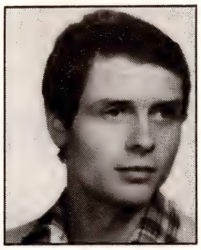
Signed ______________________________

Date ______________________________

Your vote determines this issue's winner. All designs published win $75 cash. All issue winners receive an additional $100 and become eligible for the annual $1500 Grand Prize. **Vote now,** by circling the appropriate number on the reader inquiry card.

ISSUE WINNER

The winning Design Idea for the February 4, 1988, issue is entitled "Zero-current sensor protects relay contacts," submitted by B Erik Valeur of Electronic Instrument & Specialty Corp (Stoneham, MA).



Winning Idea improves upon earlier design

Andrzej Partyka's Design Idea, "Frequency divider generates 50% duty cycle," is the 1987 Design Idea of the year, and Mr Partyka is the recipient of the $1500 cash award that goes along with it. The Design Idea originally appeared in the September 3, 1987, issue of EDN, but Mr Partyka got the inspiration for his winning idea from an earlier issue of EDN.

As he read Irwin Cohen's entry, "Divider produces symmetrical output" in EDN's January 23, 1986, issue, he realized, "it could be done better." According to Mr Partyka, his approach to obtaining a 50% duty cycle has the advantage of being more elegant and easier to comprehend. In addition, his solution is more general, and therefore more applicable. (Of course, there's nothing wrong with Mr Cohen's Design Idea—it didn't win the grand prize, but it did garner the $75 issue-winner prize.)

Mr Partyka currently lives in New Jersey, but he grew up and went to school in Poland. He attended Silesian Polytechnic Institute in the city of Gliwice in southern Poland. In 1981 he received a BS in electronics, and in 1982 he earned an MS in the same discipline. Shortly thereafter he moved to New Jersey and began working for Blonder Tongue Labs, where he was involved in voice and television signal coding. He now works in Syosset, NY, for Ademco, a company that specializes in security hardware and servicing. Mr Partyka was hired to work on long-range radio communications, but he's also interested in bandwidth-efficient and spread-spectrum data communications.

Outside of the sphere of electronics, Mr Partyka's interests lie in the area of music. He enjoys listening to classical music in particular. Despite his claims that, because he doesn't play an instrument, he isn't an artist, it's obvious that he is creative. All of the editors at EDN congratulate you, Mr Partyka, for winning the 1987 Design Idea grand prize.—*Clare Mansfield*

Insert, twist and the
bayonet type fuse is locked.
Push in, twist and out it comes.
What could be simpler?

Now a cord that eliminates the trauma of short circuit and overload damage.

. . . it's the revolutionary Belden® Fused Line Cord

This innovative Belden cord protects against potentially dangerous short circuits anywhere in the cord or the electrical device it serves.

It incorporates a field replaceable Buss® fuse. The fuse is designed to identify a fault instantly and clear the circuit at the male termination of the cord.

This new Belden product is engineered to handle motor starting loads without nuisance blows, yet it provides exceptional protection against overload damage. If your product can be subjected to indiscriminate overloads by an end user, the Belden Fused Line Cord offers exceptional protection.

If your product design has run out of internal real estate you can gain a little ground by using our Fused Line Cord. It saves space as well as the cost of a fuse, fuse holder and installation. And the Fused Line Cord makes fuse replacement a whole lot easier and safer, too!

If your product doesn't have short circuit protection—and it's required in some applications—this cord could increase your market potential. It solved this kind of problem for a major lighting manufacturer and saved a six figure order. If your product already has internal protection, the fused line cord adds extra protection from power source to product.

The Belden Fused Line Cord is UL listed. For many products it is the most positive method and economical way to meet National Electrical Code requirements.

We're offering this product in a wide range of conductor sizes and fuse ampere ratings of 1/4 through 6 amps. Replacement fuses are available now in over 3500 electrical and electronic distributor locations coast-to-coast. So if you're looking for extra protection for your product, take a close look at the new Belden Fused Line Cord. *There is no equal*™.

If you want more information or would like to see a dramatic product demonstration or video taped presentation of this revolutionary product, please call or write today. Belden Wire and Cable, P.O. Box 1980, Richmond, IN 47375

1-800-BELDEN-4

(in Indiana, call 317/983-5200)

There is no equal.™

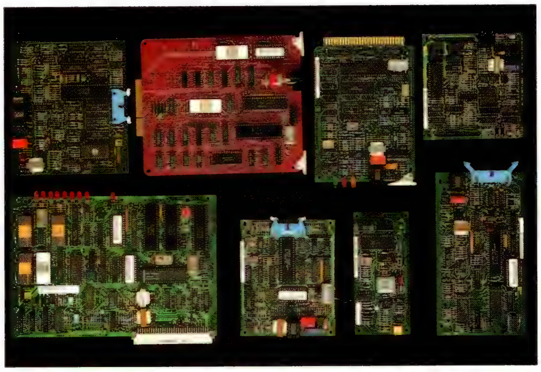
BELDEN
COOPER INDUSTRIES

Copyright ©1987, 1988 Cooper Industries, Inc.

See Our Catalog in EEM

CIRCLE NO 255

OEMs and modems: four cost effective reasons to have UDS in your corner



1. Concentration: spend your time and money on what you do best.

You excel at what you do; we excel at designing and producing modems. Devote yourself to developing and marketing your products more effectively, and get the modems you need from us. We have invested heavily in automated production equipment, test instrumentation and a large technical staff so you won't have to.

2. Reliability: because nothing costs like something that doesn't work.

Once you receive an OEM modem from UDS, install it, ship it and forget it. Our quality assurance procedure ranges from incoming chip burn-in to 100% testing of all modems prior to shipment. This attention to quality assurance has put our historical reliability rate near the 99th percentile.

3. Experience: we have already solved most of your problems.

Over the past 15 years, we have designed, produced and delivered more than 1,500,000 modems in over 3,000 different configurations. We have proved our capability to fulfill nearly any form, fit and function requirement from 0–300 to 14,400 bps.

4. Commitment: more than a promise, it's our reputation.

Supplying an edge in price/performance begins and ends with commitment. UDS is committed to the manufacture of modems – and only modems. We're also committed to the needs of OEMs, who buy over 50% of the modems we make. We have built a position as an industry leader by honoring commitments – commitments to your quality demands, commitments to your deadlines, commitments to your demand for value.

Get us in your corner.

Contact us, and we'll help you corner your share of datacomm market. Let's talk specs and prices! Universal Data Systems, 5000 Bradford Drive, Huntsville, AL 35805. Telephone: 205/721-8000; Telex: 752602 UDS HTV.

UDS Universal Data Systems
MOTOROLA INC.

TELEPHONE: 800/451-2369

Created by Dayner/Hall, Inc., Winter Park, Florida

CIRCLE NO 254

Molex Is Making The Connection Between . . .

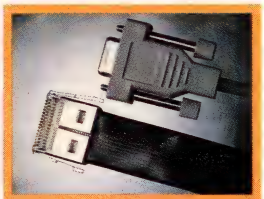
DURABILITY & SIMPLICITY

Durable, SEMCONN shielded cables/plug assemblies reduce labor costs in a wide range of easy in/out applications.

With the versatile new Molex SEMCONN™ shielded electromagnetic connector, cable assembly is easy in, easy out.

Only Molex could design a plug and receptacle interconnection system so advanced, yet so simple. Positive locking plugs with redundant dual point contacts make assembly a snap. Fully shielded against EMI/RFI for high speed data busing. And available in both flat or round cable plugs. The versatile SEMCONN connector system speeds production time and saves money.

Plug into the world's most reliable, I/O connector system.



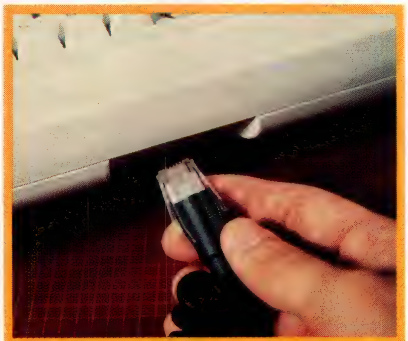
SEMCONN plugs insert faster and more securely than standard models, without the additional hardware.

At 500 cycles, you can't find a more durable connector. All SEMCONN cable assemblies are 100% tested so you're assured of reliable, quality performance when you need it most. And Molex utilizes Statistical Process Controls and Zero Defects manufacturing objectives, so reliability is built into every product.

When your cable assembly needs go beyond the standard, there's Molex.

Whether your application is computers or instrumentation, power supplies or business machines, Molex has the interconnection solution that's right for you. Combine 20 years of interconnection ingenuity and know-how with the proven engineering and technical support of the Molex trained staff, and together, we can solve any cable challenge.

Let Molex put their knowledge and experience to work for you. For more information, call or write today for our new SEMCONN Technical Catalog.



Molex's first shielded interconnection system, SEMCONN, provides protection from electrical noise.

molex®

Service To The Customer . . . Worldwide

Corporate Headquarters: 2222 Wellington Ct., Lisle, IL 60532 USA, (312) 969-4550 • *European Headquarters:* Munich, West Germany, 49-89-4960937
Northern Asia Headquarters: Tokyo, Japan, 03-487-8333 • *Southeast Asia Headquarters:* Jurong Town, Singapore, 65-265-4755

CIRCLE NO 247

LOOKING AHEAD

EDITED BY CYNTHIA B RETTIG

US capacitor sales are on the way up

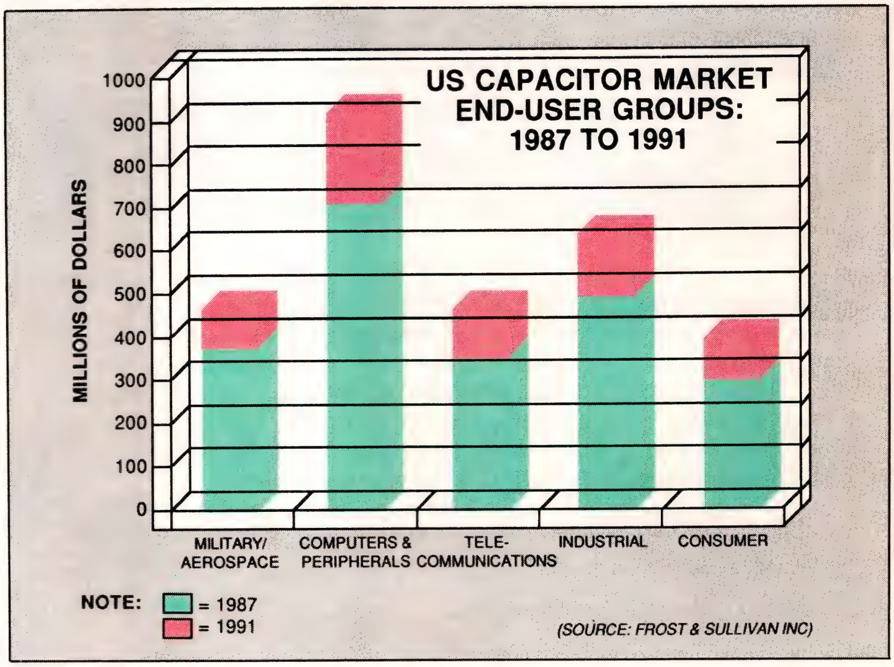
Capacitor sales, which are closely linked to the health of the computer-and-peripherals markets, have suffered markedly as a result of the slump in the market for PCs. An OEM build-up caused a 27% rise in the dollar value of the capacitor market in 1984, only to be followed by a 30% decrease in capacitor demand in 1985. Now, however, the capacitor market is recovering, according to Frost & Sullivan. The New York market-research firm predicts 6.1% growth in sales dollar value and 9.4% growth in unit sales by 1991. The sale of 26.8 billion capacitors in 1991 will gross $2.9 billion—partly as a result of decreased prices stemming from the large volume of OEM accounts.

Sales in 1987 are estimated to have been worth $2.2 billion, which constitutes a 5.6% increase over the previous year's figure; 1987 unit sales are calculated to have been approximately 18.6 billion, 9% greater than 1986 unit sales.

The capacitor market is divisible into five principal OEM end-user categories: computers and peripherals, industrial, military/aerospace, telecommunications, and consumer. The computers-and-peripherals segment generated 31.1% of the dollar value of the 1986 market and is expected to account for nearly one-third of capacitor demand through 1991. Industrial sales, the next largest segment, will represent approximately 22% of the market through the forecast period. Demand for capacitors among military/aerospace OEMs is expected to grow quite slowly and to decline from 17.3% of the market in 1986 to 16.3% in 1991. The telecommunications sector will steadily consume just over 16% of the capacitor market, whereas consumer OEMs will increase their level of demand to 13.3% by 1991.

An examination of the capacitor market in terms of suppliers reveals that the top five suppliers claim 46% of the total US market, and the top ten, 62%. This situation is expected to persist, leaving the rest of the market to some 200 smaller suppliers. However, smaller suppliers who specialize in custom design should see their opportunities grow over the next few years. Product quality and the ability to offer just-in-time delivery should also prove advantageous for some suppliers, as will flexible operations.

Miniaturization and surface-mount technology will constitute significant factors across the entire market. Although surface-mount technology currently accounts for only about 12% of the US market, in Japan, it already claims 35%. By 1990, 50% of US products are expected to employ SMT.



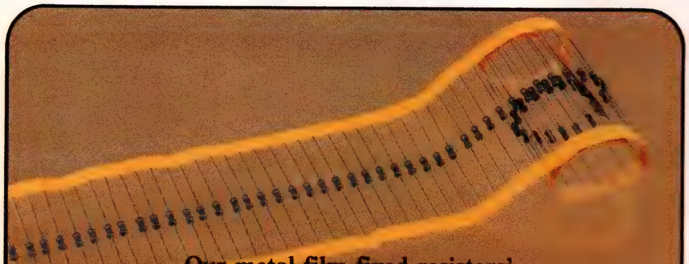
(SOURCE: FROST & SULLIVAN INC)

LAN market to grow at 20% rate through '91

According to Arthur D Little Decision Resources (Cambridge, MA), the US market for local-area networks should grow from $520 million in 1986 to $1.3 billion in 1991, which translates into a 20% annual growth rate for the domestic market. Although all application areas will expand during this period, office applications will continue to constitute the largest segment, claiming about 41% of the LAN market by 1991. Factory and medical applications, however, should both grow more quickly—at annual rates of 58% and 35%, respectively, over the next few years. In general, prices are expected to decline about 3%.

Key issues for LAN suppliers vary from one application area to another, but, as is often the case today, interconnectivity emerges as a primary concern; the ability of LANs to cross the technical borders between various types of equipment is crucial to vendors, third-party vendors, and users alike. Joint ventures and consolidation to offer specialized products will serve as major avenues to growth for US LAN businesses; distribution techniques, relationships with value-added resellers, the availability of total systems, and software quality will also prove important factors.

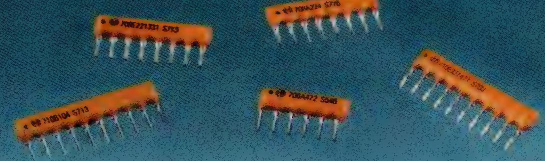
When quality counts, count on Allen-Bradley



Our metal film fixed resistors' performance meets or exceeds MIL-R-10509

Nichrome resistance element provides stable performance. TCR is less than 100 ppm/°C over the full range of values . . . 10Ω to 1 MΩ . Standard tape and reel or bulk packaging. Experience Allen-Bradley quality at a very reasonable price. Call 800-592-4888 or 800-292-4888 in Texas.

ALLEN-BRADLEY
A ROCKWELL INTERNATIONAL COMPANY
1414 Allen-Bradley Drive, El Paso, TX 79936-6415



Conformal coated cermet resistor networks. . .6, 8, 9, 10 pins

Our C-SIP networks provide world class performance at competitive prices. Space saving low profile, stable thick film elements, 4 through 14 pins available in addition to above standards. High quality, low cost. Call 800-592-4888 or 800-292-4888 in Texas.

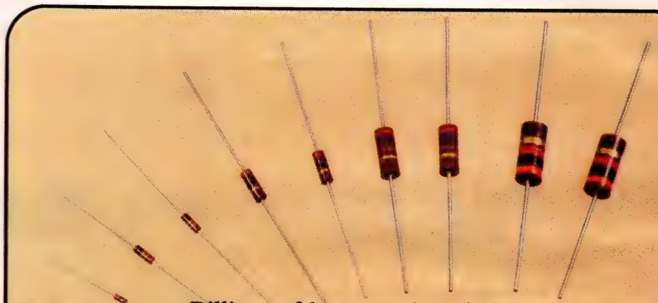
ALLEN-BRADLEY
A ROCKWELL INTERNATIONAL COMPANY
1414 Allen-Bradley Drive, El Paso, TX 79936-6415

Surface mount SARAs and chip resistors

SARAs . . . resistor networks with solder bumped terminations for surface mount applications. Compatible with automatic placement equipment. Cost effective solution for space-saving custom circuitry. User trimmable.

Chip Resistors . . . 1206 and 0805 sizes. Laser trimmed thick film resistance element. Tight TCR. 5% and 1% tolerance in high volume. Utilizes Statistical Process Control in manufacturing for built-in quality. Call 800-592-4888 or 800-292-4888 in Texas.

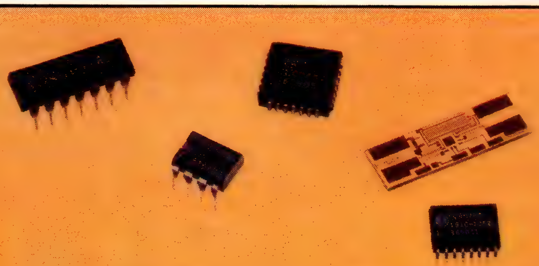
ALLEN-BRADLEY
A ROCKWELL INTERNATIONAL COMPANY
1414 Allen-Bradley Drive, El Paso, TX 79936-6415



Billions of hours and no failures ... A-B fixed carbon composition resistors

We deliver on time. Meet or exceed all applicable military specifications including MIL-R-39008 and qualified to reliability level S. ⅛ Watt through 4 Watt @ 70°C. Call 800-592-4888 or 800-292-4888 in Texas.

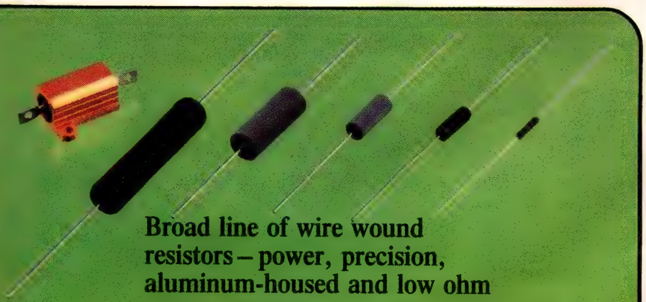
ALLEN-BRADLEY
A ROCKWELL INTERNATIONAL COMPANY
1414 Allen-Bradley Drive, El Paso, TX 79936-6415



Thin film precision resistor networks

Consist of integrated films of chromium cobalt vacuum deposited on specially selected glass or alumina substrates resulting in networks having precision tolerance and stability. Molded and ceramic DIP, ceramic SIP, surface mount, alumina and glass chip, and hybrid network substrates. Standard designs and custom circuits and packages. Meets MIL-R-83401 characteristic. Call 800-592-4888 or 800-292-4888 in Texas.

ALLEN-BRADLEY
A ROCKWELL INTERNATIONAL COMPANY
1414 Allen-Bradley Drive, El Paso, TX 79936-6415



Broad line of wire wound resistors – power, precision, aluminum-housed and low ohm

Choose Type WW to meet your power requirements (½W-14W) in a small package. Choose Type W8 for your precision requirements. Our Type WA will meet your high power (5W-50W) needs, and our Type WL provides the very low ohmic values you require. All of our wirewounds are competitively priced and backed by Allen-Bradley quality. Call 800-592-4888 or 800-292-4999 in Texas.

ALLEN-BRADLEY
A ROCKWELL INTERNATIONAL COMPANY
1414 Allen-Bradley Drive, El Paso, TX 79936-6415

CIRCLE NO 248

THE SOUND OF A SEIKO THERMAL PRINTER.

If you need a printer that's very, very quiet, here's something to shout about. The DPU-411 from Seiko Instruments. It's so quiet, you'll forget it's there. So you can work while it does.

And thanks to its small size and rechargeable battery back-up, it's completely portable. In fact, at a featherweight 2.2 pounds, you can take it wherever you need a small, ultra-quiet printer.

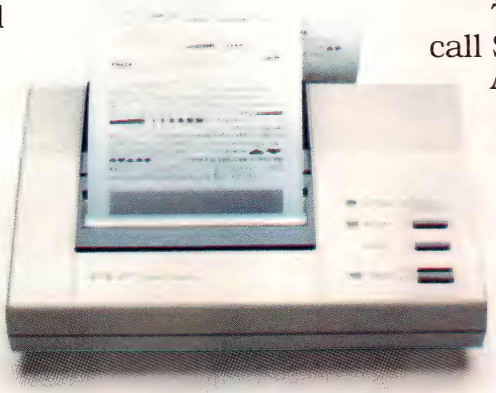
With both RS232C and Centronics 8-bit parallel interfaces standard, the DPU-411 will fit easily into your system. And you can print either a standard 40 column or condensed 80 column line.

Of course, like all Seiko printers, it's manufactured for a long life.

What's more, the only maintenance you'll ever need to perform is putting in new paper. Which means it won't create any noise from people yelling about messy ribbons or upkeep.

It won't cause any noise when you get the bill, either. Because the DPU-411 is very competitively priced.

To help keep your office quiet, call Seiko today at (213) 517-7770. And ask about the thermal printer that's quiet, portable and affordable.



SEIKO I

Seiko Instruments USA

2990 West Lomita Blvd., Torrance, CA 90505
(213) 517-7770 • FAX: (213) 517-7792

CIRCLE NO 249

PC BUS Card Cages

RUGGED
Designed for industrial use. Captive mounting hardware, .063″ aluminum structure.

PASSIVE BACKPLANE
Five, seven or ten slots, for XT®, AT® and 386 compatible single board CPUs and accessory cards.

FLEXIBLE
Wide range of options available: CPU cards, fans, power supplies, function boards, memory devices, others.

Save time and money. Choose from six standard PCBus models and add options for the configuration you need. All passive backplanes have four layers, with internal voltage and ground planes. Speaker leads, keyboard cable and connectors included.

From single-board CPUs to complete systems, we can meet your PCBus computer requirements. For more details, contact your nearest TMI sales office or our Houston headquarters.

TEXAS MICROSYSTEMS
INCORPORATED
10618 Rockley Road • Houston, Texas 77099
(713) 933-8050
1-800-627-8700
Designers and manufacturers of ***quality*** *computers for more than a decade*

©1988, Texas Microsystems Incorporated

CIRCLE NO 113

AD INDEX

Sophia Systems Co Ltd 153
The Soundcoat Co 311
Spang Power Control 331
Spectron Glass and Electronics 304
Spectrum Software 39
Sprague Electric Co 79
Stag Microsystems Inc 162
Standard Grigsby Inc 292
Standard Logic 260
Stanford Research Systems Inc 81
Statek 333
Tai-Kung Enterprise** 151
Taiwan Liton Electronic Co Ltd 289
Taiwan Zetatronics 330
Targa Electronics Systems Inc 329
Tauber Electronics 310
TDK Corp 232
TEAC Corp** 149
Tektronix Inc 34-35, 117, 154-155, 170, 220-221
Teledyne Philbrick 159
Teledyne Semiconductor 16-17
Texas Instruments Inc 163-166
Texas Microsystems Inc 366
Thomas and Betts Corp 203
Titan/SESCO 316
Tokin Corp 363
Torema USA 271
Toshiba America Inc 42-43
Toshiba Corp 328
United Technologies
Microelectronics Center* 76
Universal Data Systems C3
Varta Batteries Inc 343
VCH International 44-45
Vesta Technology Inc 335
Vishay 151
Wells-Gardner Electronics Corp . . . 310, 311
Winpoint Electric Corp 332
WinSystems Inc 334
Wintek Corp 332, 333
Wollongong Group 251
Xender 334
Zax Corp 96-97
Zenith Electronics 287
Zericon 333
Ziatech Corp 246A-F
Zilog Inc 241
Zippy Shin Jiuh Corp 333

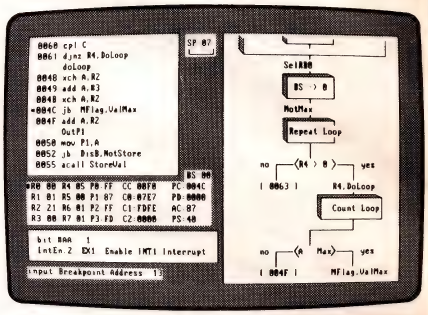
Recruitment Advertising 354-361

Bell Aerospace—Textron
Litton Data Systems
NAC
Opportunity Center

*Advertiser in US edition
**Advertiser in International edition

This index is provided as an additional service. The publisher does not assume any liability for errors or omissions.

IBM-PC based microcomputer development tools!



```
0060 cpl C
0061 djnz R4,DoLoop
     doLoop
0048 xch A,R2
0049 add A,R3
004B xch A,R2
*004C jb  MFlag,ValMax
004F add A,R2
     OutP1
0050 mov P1,A
0052 jb  DisB,NotStore
0055 acall StoreVal

SP 07
BS 00
*R0 00 R4 05 P0 FF  CC 00F0   PC 004C
 R1 01 R5 00 P1 87  C0:07E7   PD:0000
 R2 21 R6 01 P2 FF  C1:FDFE   AC 87
 R3 00 R7 01 P3 FD  C2:0000   PS:40

 bit 0AA   1
 IntEn.2  EX1  Enable INT1 Interrupt
input Breakpoint Address  13
```

(8051 debug/simulator shown)

Your IBM PC can Assemble, debug and program (EPROM) code for these popular microcomputers:

	dBUG	XASM	PROG
8096	✓	✓	✓
8051	✓	✓	✓
8049	✓	✓	✓
7000	✓	✓	✓
8088	✓		✓
8085		✓	✓
320		✓	✓
Z8		✓	✓
	$595 except 8096 and 8088	$295	$245 Kit form

Step your code, watch registers & memory change, interrupts occur, stack push & pop. Flowgraph auto-documents code! You set breakpoints & register traps, count machine cycles, and scan source code and symbols. Single-key commands prompt for arguments if needed. Have more fun and get more done!

debug demo diskette and manual only $39.50

Cybernetic Micro Systems
P.O. Box 3000
San Gregorio, CA 94074 U.S.A.

(415) 726-3000 • Telex 171135 Attn: Cyber

CIRCLE NO 250

ADVERTISERS INDEX

Abbott Transistor Labs Inc	105
Abionics	330
Academic Press/ A Div of HBJ Publishers	338
ACCEL Technologies Inc	335
ACDC Electronics	270 295
Acromag Inc	306
ADC Telecommunications	333
ADPI	331
Advanced Interconnections Corp	290
Advanced Micro Devices/ Monolithic Memories Inc	C1
Advin Systems	332
Aerovox Mallory	325
Airborn	54
Airpax Corp/Cambridge Div	305
Allen Systems	335
Allen-Bradley Co	368
Altera Corp	50-51
Amco Engineering	252
American Eltec	337
AMP	106-107
Amperex Electronic Corp*	151
Analog Devices Inc	12-13, 253
Antona Corp	329
Applied Data Systems	333
Applied Microsystems Corp	235
Arium Corp	315
AT&T Technologies	83-85
Augat-Interconnection Systems	313
Avocet Systems Inc	261
Ballard Technology	331
Bayer AG**	18-19
B&C Microsystems	332, 335, 336
Belden Wire & Cable	C4
Big Three Industries/Tempil Div	333
BKL Industries	330
BP Microsystems	335
Brooktree Corp	298-299
Bud Industries Inc	349
Burr-Brown Corp	265
BV Engineering	332
Bytek Corp	317
CAD Software Inc	169, 171
CADdy Corp	275
Capital Equipment Corp	336
Carlingswitch	207
Carroll Touch Inc	215
Cermetek Microelectronics Inc	201
Cherry Electrical Products Inc	330
Chomerics Inc	136-137
Ciba-Geigy	222-223
C&K Components Inc	272
Comair Rotron Inc	364
Comlinear Corp	245, 322
Computer Dynamics	277
Computer Products Inc	143-146
Computerwise Inc	335
Condor	99
Connector Corp	324
Conversion Devices Inc	334
Cooper Tools*	74
CTS Corp	234
Cubit/Proteus Industries Inc	59, 61, 63, 65
Cybernetic Micro Systems	366
Cypress Semiconductor	178-179
Dage Precision Industries Inc	254
Daisy Systems Corp	194
Dale Electronics Inc	1
Dash, Straus, and Goodhue	2
Data I/O Corp/Futurenet Div	8
Datron	48
Deltrol Controls	334
Deltron Inc	278
Dialight Components	72-73
Digelec Inc	312
Digital Electronics Corp	219
Digital Engineering	40
Digital Media Inc	329
DSP Development Corp	340
Eagle Magnetic	264
Eagle Picher	168
EAO Switch Corp*	302
Eaton Corp	339
EF Johnson Co	329
Elan Digital Systems	324
Eldre Components Inc	330
Electro Mechanical Devices	334
Elma Electronic	167
Emcor Products/Crenlo Inc	259
Ericsson	258, 274, 345
E-T-A Circuit Breakers	326
Farnell International Ltd**	76
Finlux	141
Force Computers Inc	30-31
Fujitsu Components of America Inc*	266
Fujitsu Microelectronics Inc*	14-15
GE Plastics	257
GE/RCA Intersil Semiconductors	36-37, 52-53, 176-177, 303
Gould Inc, Test & Measurement Group	187
Grayhill Inc	255
Hamilton Avnet Electronics	174
Harris Semiconductor/ Custom IC's Div	204-205
Harris Semiconductor/ Linear Products Div	296
HEI Inc	262
Heurikon Corp	173, 175
Hewlett-Packard Co	6, 208, 243
Hitachi America Ltd*	18-19
Huntsville Microsystems Inc*	307
Inmos Corp*	10-11
Integrated Device Technology Inc	362
Intel Corp	127
Intermetrics Inc	66
International Power Devices	278
Introl Corp	273
Intronics	288
Intusoft	332
Ironwood	332
Janco Corp	32
JETA Power Systems	269, 271, 273, 275, 277
John Fluke Manufacturing Co Inc*	20, 149
KEC Electronics Inc	135
Keithley Instruments	321
Kepco Inc	268
Kingdatram Electronics Industrial Co Ltd**	266
Leader Electronics	333
Leader Instruments Corp	323
Leadyear Enterprise Co Ltd	336
Ledtronics Inc	304
Lemo USA Inc	88
Linear Technology Corp	236
Logic Devices	231
Logical Devices Inc	329
Logical Systems Corp	336
LTX Corp	86-87
Macronix	133
Magnesys	138, 335
Mascot**	266
Matra Harris Semiconducteurs	292
Maxell	161
Maxtor	46
Melcher	256
Memocom	335
Mepco/Centralab	263
Microcomputer Control	330
Micro/Sys	344
Microtec	128
Mini-Circuits Laboratories	3, 4, 26-27, 239
Mizar Inc	23
Modutec Inc	318, 319
Molex Inc	370
Motorola Microcomputer Div	28-29
Motorola Semiconductor Products Inc	217
Mueller Electric Co	329
Multibus Manufacturers Group	67-70
MWS Wire Industries	172
National Instruments	314
NCI	331
NCR Microelectronics Div	248
NCR Power Systems	233
NCR Wichita	309
Nichicon Corp	342
NMB Semiconductor Corp	56
NTT International	346
Octagon Systems	331
OKI Semiconductor	188-189
Omation Inc	334
OrCAD Systems Corp	71
Orion Instruments	347
Panasonic Industrial Co*	341
Panduit Corp	293
Papst Mechatronic	353
P-Cad	247
Phihong Enterprise Co Ltd**	74
Philips Elcoma Div**	14-15, 192-193
Philips Test & Measuring Instruments Inc**	307, 341
Plastics Engineering Co	300, 301
Polaroid Corp	38
Powerex Inc	102-103
Powertec Inc	118
Precision Interconnect	157
Precision Monolithics Inc	33
Pro Lib Inc	336
Programmable Logic	331
Pulizzi	331
Pulse Instruments	320
Qua Tech Inc	332, 336, 339
Qualidyne Systems Inc	269
Quality Tech	41
Quantum Corp	190-191
Raytheon	25
Ready Systems	108-109
Rifa Inc	206
Rifa Inc/Capacitor Div	291
RLM Research	336
Rogers Corp	331, 334, 336
Rohde & Schwarz**	20
Runit Controls	331
Saft America Inc	327
Samsung Semiconductor	119-126
Samtec Inc	100-101
Schroff	350
Scientific Calculations	250
Sea Level Systems	330
Seiko Instruments	367
SGS-Thomson Microelectronics*	94-95
SiemensAG**	10-11, 94-95
Silicon General	224
Silicon Systems Inc	92-93
Simpson Electric Co	276
Single Board Solutions	334
S-MOS Systems*	192-193
Sony Corp of America	91

How to put brainpowe into your airpower.

Therma Pro-V T

FORCED CONVECTION
COOLING TECHNOLOGY

With the recent introduction of Comair Rotron's patented ThermaPro-V technology, commercial airmovers started talking a language all their own. And that's good news for design engineers who require intelligent components for their complex circuitry. Now, that same intelligence has been added to Comair Rotron's high-end computer and telecommunications Major DC and Patriot DC fans.

Major DC and Patriot DC with ThermaPro-V

For a company whose engineers are market driven, adding two very popular product lines incorporating the revolutionary ThermaPro-V technology should come as no surprise. Acoustically quiet, highly adaptive to hostile environments, this cooling technology offers continuous motor speed adjustments. The closed loop Thermal Speed Control system automatically regulates airflow as a function of temperature. The Programmability feature allows for simple fan speed changes while Voltage Regulation assures constant airflow even while experiencing voltage fluctuations — all within the 6.75" X 2" Major DC and Patriot DC fans delivering 240 CFM

Fan Performance Sensors

But, in addition to ThermaPro-V, Comair Rotron also offers Fan Performance Sensors (another smart idea invented by Comair Rotron) on Major DC, Patriot DC and Spinnaker DC. Detecting reduced airflow, avoiding excessive internal temperatures and preventing component damage through a precise monitoring and remote warning system, makes Fan Performance Sensors a must for today's electronic equipment.

Separate or in Combination

Whether its the unique capabilites of ThermaPro-V technology or a combination of TPV with the warning system of Fan Performance Sensors, Comair Rotron can provide the brainpower for all your airpower needs. Call us today for additional information.

Comair Rotron. The First Name in Forced Convection Cooling Technology

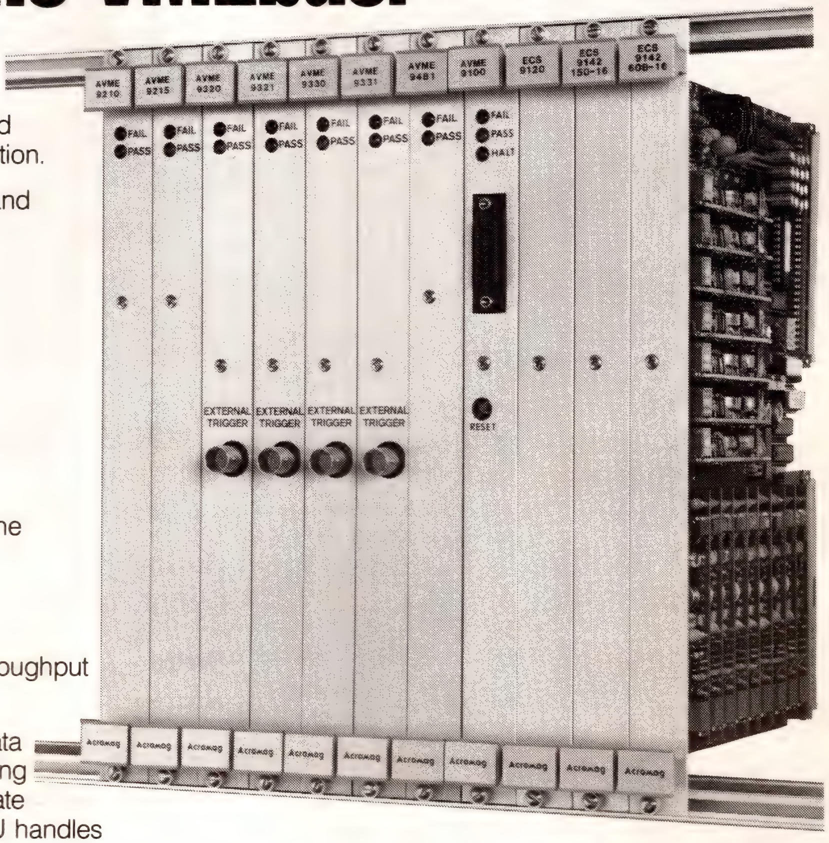
COMAIR ROTRON

a KLI company

12 North Street, Sawyer Industrial Park, Saugerties, NY 12477-1096 Tel: (914) 246-3615 TWX 910-333-7572 TLX: 551496

CIRCLE NO 251

Acromag has solutions for interfacing A/D, D/A and Digital I/O signals to the VMEbus.



Our extensive line of VMEbus-based products handles your interfacing applications for test and measurement, industrial control, or data acquisition.

If you need to interface with industrial sensors and industry standard field signals:

DC VOLTS OR CURRENTS
MILLIVOLT
THERMOCOUPLE
RTD
AC VOLTS OR CURRENTS
STRAIN GAUGE
PRESSURE
FREQUENCY

We have total solutions from the field wiring to the VMEbus.

PERFORMANCE

For basic A/D conversion, we've incorporated many operational features to improve overall throughput to your host processor.

For more advanced applications, Acromag's Data Acquisition Subsystem simplifies sensor interfacing and reduces host activity. So you can concentrate on processing the data while our on-board CPU handles routine tasks.

Function	In/Out	Max Signal Range**	Features	Product
High-Speed Analog I/O	16D/32SE*in 2 out, opt.	±10 in/out	12 Bit A/D, 67K chan/sec throughput 12 Bit D/A	AVME9320 AVME 9321
High-Res. Analog I/O	16D/32SE in 2 out, opt.	±10 V in/out	14 Bit A/D, 33K chan/sec throughput 12 Bit D/A	AVME 9330 AVME 9331
Analog Out	8 out	±10V, Vout 4-20mA, Iout	12 Bit D/A, 6 μ sec Vout, 25 μ sec Iout, throughput	AVME9210 AVME 9215
Data Acq. Controller	16D/32SE in, opt.	±10V	14 Bit A/D, 256 in, scans, linearizes, limit checks	AVME9100 AVME9110
Subsystem Expanders	16D/32SE in	±10V	High level expander	ECS9120
	16D in	±10V	Filtered inputs	ECS9121
	8D/16D in	−6 to +60mV −15 to +150mV Thermocouple	250V isolation, interface for TC, RTD, and Pressure with termination panels	ECS9142-60 ECS9142-150 ECS9142-60B
Digital I/O	64 in/out	0-30V in/out	8 in with latch and interrupt	AVME9480 AVME9481

*SE - Single ended D - Differential
**Most inputs and outputs have programmable ranges.

SUPPORT PRODUCTS

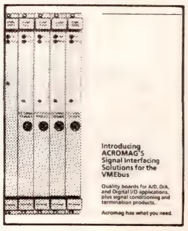
Acromag's termination products interface to your field wiring using screw terminals and to the VME backplane using ribbon cable. I/O connections are at the rear of the boards.

The modular, high-accuracy analog signal conditioning system connects to any of our VME high-level analog boards—like a termination panel. Available modules cover virtually all signal types and provide electrical isolation.

And we provide a comprehensive software support package for VERSAdos—with drivers, diagnostics, and a subroutine library in 'C'.

QUALIFICATIONS

Let Acromag's 30 years of experience in signal interfacing benefit you. When you need to interface analog or digital signals to the VMEbus, call or write today. For more information request "Acromag's Signal Interfacing Solutions for the VMEbus" bulletin.



Introducing ACROMAG'S Signal Interfacing Solutions for the VMEbus

Quality boards for A/D, D/A, and Digital I/O applications, plus signal conditioning and termination products.

Acromag has what you need.

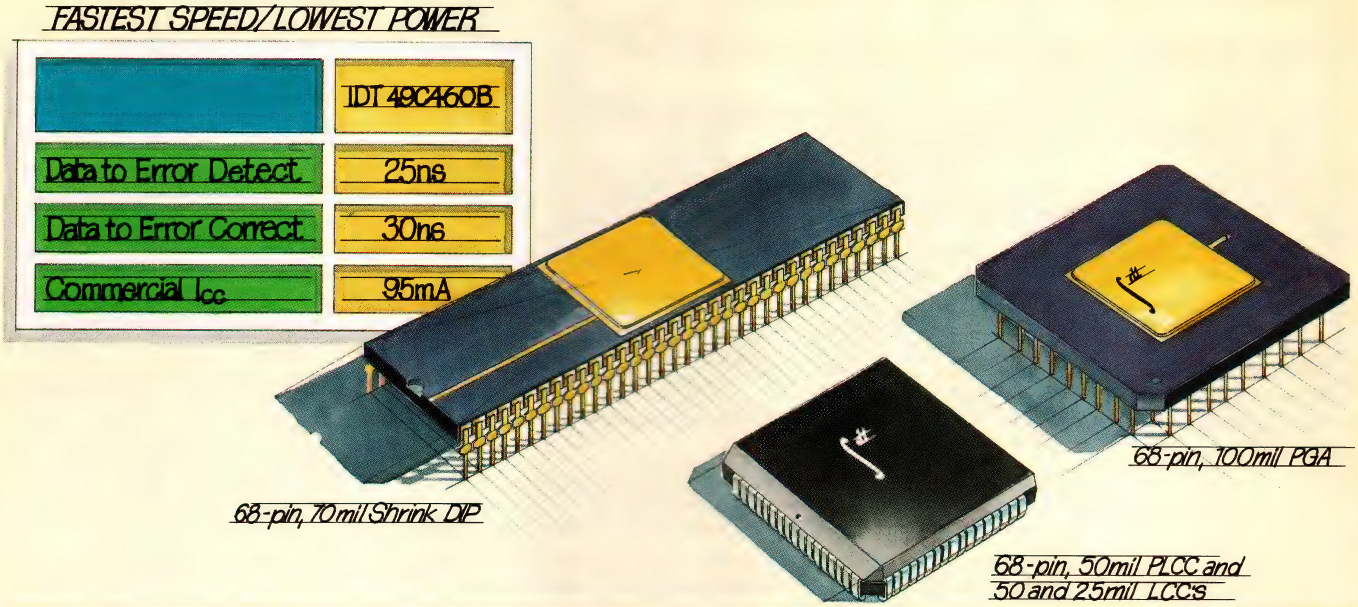
Acromag®
LEADER IN SIGNAL CONDITIONING
30765 Wixom Road, Wixom, MI 48096
(313) 624-1541, Telex: 247354

CIRCLE NO 229

World's Fastest

32-bit CMOS EDC

25ns DETECT TIME


FASTEST SPEED/LOWEST POWER
68-pin, 70mil Shrink DIP
68-pin, 100mil PGA
68-pin, 50mil PLCC and 50 and 25mil LCC's

	IDT49C460B
Data to Error Detect	25ns
Data to Error Correct	30ns
Commercial I_{CC}	95mA

IDT49C460B: fastest speed, lowest power 32-bit EDC.

Your memories are getting bigger and with that comes higher error rates. Use the new, faster IDT49C460B to enhance data integrity. It corrects all single-bit errors, detects all double and some triple-bit errors.

Replaces 2960s. You can easily upgrade existing 2960 systems with the IDT49C460B because both devices use the same Hamming code. Your design benefits from faster speed, improved power consumption and a 3-to-1 reduction in chip count. Byte writes, byte operations and diagnostics are included.

Faster than bipolar. The IDT49C460B detects an error in 25ns and corrects in 30ns. Nothing is faster.

Lowest power. The only 32-bit EDC in CMOS consumes just 95mA commercial. Now you can get EDC faster than the fastest bipolar but with CMOS power.

Cascades to 64 bits. Only IDT offers you a simple, two chip solution for 64-bit EDC. (The TI632 cannot be cascaded to 64-bits; while the Am2960 approach requires 14 devices.)

16-Bit EDC

	IDT39C60A	IDT39C60-1	IDT39C60
Data to error detect	20ns	25ns	32ns
Data to error correct	30ns	52ns	65ns
Commercial I_{CC}	85mA	85mA	85mA

Speed leadership in 16-bit EDC.

We also make a family of 16-bit CMOS EDCs. All are 2960 pin compatible with improved output drive while consuming only 1/4 the power.

The IDT39C60A is unquestionably the highest performance TTL compatible CMOS 16-bit EDC in the world. And more than just some "specs on paper," it's *available now—in volume.*

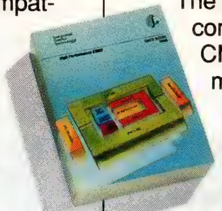
The IDT39C60-1 and IDT39C60 are equal in speed to both the 2960-1 and 2960.

Packages. ☐ 48-pin plastic and ceramic DIPs. ☐ 52-pin PLCC/LCCs.

Cascadable. Up to 64 bits.

Ask for your FREE Data Book!

Everything you want to know about cool and fast EDC is in our new, 1800 page ***1988 DATABOOK***. Call your local IDT representative or **(408) 492-8314** and ask for your FREE copy.

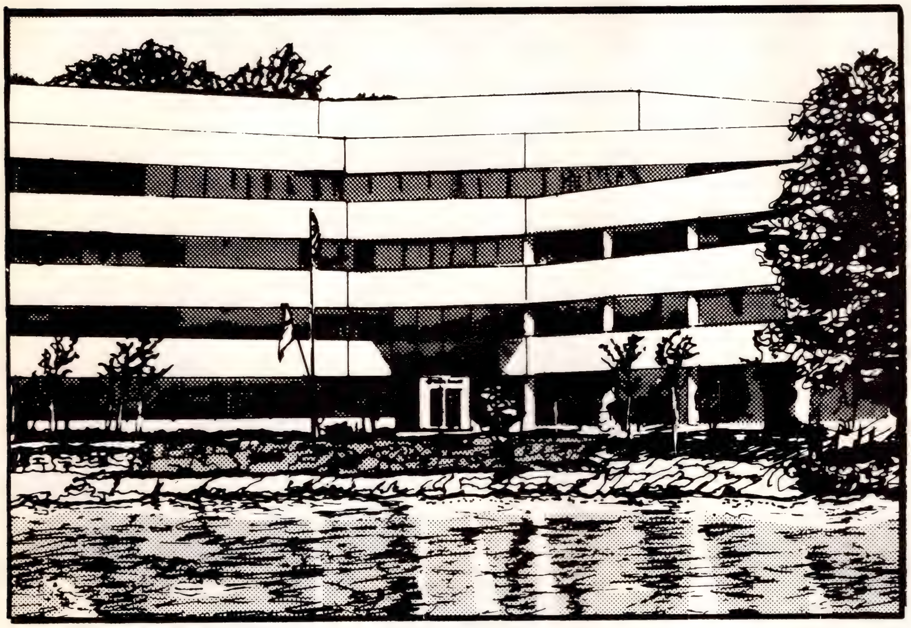


The DATABOOK also contains complete information on our CMOS Static RAMs • specialty memory products such as FIFOs and DUAL-PORTs • ultra-fast RISC processors and bit-slice ALUs • Multiplier-Accumulators and Floating-Point Processors • TTL logic • Data Conversion products • ECL Interface products • E² Memories.

Integrated Device Technology
3236 Scott Blvd.
Santa Clara, CA 95054-3090
(408) 492-8314
FAX: 408 727-2328

CIRCLE NO 252

ELECTRONICS ENGINEERING OPPORTUNITIES



GROUP HEADQUARTERS, SHELTON, CT

MAXIMUM INNOVATION! We demand it at BLACK & DECKER. We're the leading producer of household products worldwide because we attract the most talented Engineers, supply them with state-of-the-art equipment and allow them the latitude to develop and refine new ideas.

With the introduction of our Advanced State-of-the-Art Wireless Electronic Security System "HOME PROTECTOR™" and its national consumer acceptance, we are now at the leading edge of the electronics industry and have excellent opportunities for qualified Electronics Engineering Professionals to assume challenging roles as part of our expanding dynamic team at our Shelton, CT facility.

ELECTRONICS PROJECT ENGINEER

Your responsibilities will include digital and analog design for high volume electronic consumer products, electronic project leadership from inception to first production, Custom, Standard Cell and Gate Array integrated circuit design for high volume applications, microprocessor system and hardware design, as well as overseas Plant interface through production start.

To qualify, you must possess a BSEE with 5-10 years experience in state-of-the-art electronics design or product development. High volume manufacturing and a MSEE a plus.

SR. ELECTRONICS DIGITAL CIRCUIT DESIGNER

The qualified individual must have experience with hardware, software and systems integration, cost reduction and manufacturability interface. Digital hardware design includes using NOS/CMOS VLSI devices, microprocessors, ROM, RAM, PROM, programmable gate arrays, standard cell LSI devices and surface mounted components.

Experience with firmware design using the TI, Motorola and Intel microprocessor families and analog design including wave shaping, noise suppression and low-level high frequency applications are also required.

ELECTRONICS DIGITAL FIRMWARE DESIGNER

Qualifications should include functional experience in inception, design, development and analysis of firmware for advanced microprocessor systems. Logic circuit design including level and timing simulation as well as firmware/hardware partitioning. Hands-on experience using microprocessor development systems (MDS) and in-circuit emulators (ICE).

MATERIALS/METHODS ENGINEER

This experienced professional will establish the necessary criteria that guide the choice of electronic components, interconnect methods and manufacturing processes/tools used in building an advanced home security system. This position, which is closely affiliated with product quality assurance to achieve rapid product improvements, requires familiarity with high volume manufacturing techniques for advanced electronic equipment.

Make your next move. . . up to Black & Decker. . . and enjoy the excellent compensation and benefits package . . . as well as the challenge you would expect from an industry leader. Send your resume with salary history and daytime contact number, in confidence, to: Kent Aderholt, Organization & Staffing, THE BLACK & DECKER CORPORATION, U.S. Household Products Group, 6 Armstrong Road, Shelton, CT 06484. An Equal Opportunity Employer M/F.

BLACK & DECKER

IDEAS AT WORK

Job-hunting shouldn't be a wild goose chase.

Visit BPI TECH FAIR.® And stop giving your career the run-around.

Running all over town for interview appointments is for the birds. BPI TECH FAIR® lets experienced engineers, computer, DP/MIS or software professionals interview with dozens of companies at one time. In one place.

Each BPI TECH FAIR brings recruiters and line management from top local and national technical companies to your area. They're looking for experienced professionals like you. You'll get a chance to meet with many companies. Learn about other career opportunities. And save yourself a lot of time.

BPI TECH FAIR is completely confidential. There's no registration. *And we're not an employment agency.* So there's no fee.

If you're an experienced engineer, computer, DP/MIS or software professional, plan to attend the next BPI TECH FAIR. We'll take the hunt out of your job hunting.

SEARCH ME!
For on-line technical career opportunities and to transmit your resume:
DIAL 612-941-3957

Call AD LINE

On your PC or terminal and modem, enter the password **"BPI."** Search AdLine often, as companies are continually being added to the system.

Nation's #1 rated career event.

TECH FAIR®

BPI • 100 North Seventh Street • Minneapolis, MN 55403 • (612) 370-0550

Remaining 1987 Schedule: Boston, June 1-2, August 24-25, November 16-17/ **Santa Clara,** June 8-10, November 2-3/ **Washington D.C.,** June 16-17, July 27-28, September 14-15, November 23-24/ **St. Louis,** June 22-23/ **Raleigh,** June 29-30/ **Dayton,** July 20-21/ **Dallas,** August 3-4/ **Phoenix,** August 10-11/ **Orlando,** August 17-18/ **Chicago,** August 31-September 1/ **Denver,** September 28-29/ **Minneapolis,** October 5-6/ **Wichita,** October 19-20/ **San Diego,** December 7-8.

• ENGINEERS • PROGRAMMERS • ANALYSTS

MEET 35 EMPLOYERS

NOW INTERVIEWING
SALARIES $30,000 to $75,000

- New York
- Los Angeles
- Washington, D.C.
- Orlando
- Cleveland
- San Jose
- Chicago
- Huntsville
- Boston
- Dallas
- Atlanta
- Orange County
- Philadelphia
- St. Louis
- Cincinnati
- Phoenix
- Minneapolis
- Denver

- Aerospace Engineer
- Electrical Engineers
- Electronics Engineers
  - Microprocessors
  - Semi Conductors
  - Communications
- Industrial Engineers
- Mechanical Engineers
- Data Processing
  - Software Design
  - Programmers
  - Systems Analysts
- Industrial Sales
- Plant Engineers
- Chemical Engineers
- Plastics Engineers

At an Opportunity Center, you have a unique opportunity to meet representatives of top firms in private interviewing sessions all in a single day or evening. When you apply, your resume, minus your name, is reviewed by representatives of Opportunity Center sponsoring firms. You are notified as to which firms would like to meet you. PRIVATE INTERVIEWS CONDUCTED IN COMPLETE CONFIDENCE.

COMPANIES WHO HAVE ATTENDED:

- Allied Bendix
- Analysts International
- Arinc
- Arvin Calspan
- Ball Aerospace
- Bell Corporation
- Boeing
- Combustion Science Corp.
- E-Systems, Inc.
- Fairchild Republic
- FMC
- General Dynamics
- General Electric
- Grumman
- GTE Labs
- Hamilton Standard
- Harris Electronic
- Hercules Defense Systems
- IBM
- Intergraph
- ITT
- Lear Siegler
- Litton Industries
- Lockheed
- LTV
- Magnavox
- Martin Marietta
- Motorola
- Northrop Corp.
- Raytheon
- Rockwell International
- SCM Corp.
- Teledyne
- Texas Instruments
- TRW
- United Technology
- UNISYS
- Westinghouse
- Xerox Corporation

MAIL RESUME TODAY TO

OPPORTUNITY CENTER

265 S. Main St.   Akron, OH 44308

EDN Databank

Professional Profile

Announcing a new placement service for professional engineers!

To help you advance your career. Placement Services, Ltd. has formed the EDN Databank. What is the Databank? It is a computerized system of matching qualified candidates with positions that meet the applicant's professional needs and desires. What are the advantages of this new service?

- It's absolutely free. There are no fees or charges.
- The computer never forgets. When your type of job comes up, it remembers you're qualified.
- Service is nationwide. You'll be considered for openings across the U.S. by PSL and it's affiliated offices.
- Your identity is protected. Your resume is carefully screened to be sure it will not be sent to your company or parent organization.
- Your background and career objectives will periodically be reviewed with you by a PSL professional placement person.

We hope you're happy in your current position. At the same time, chances are there is an ideal job you'd prefer if you knew about it.

That's why it makes sense for you to register with the EDN Databank. To do so, just mail the completed form below, along with a copy of your resume, to: Placement Services, Ltd., Inc.

IDENTITY

Name ____________________

Home Address: ____________________

City __________ State: ________ Zip: ________

Home Phone (include area code): ____________________

PRESENT OR MOST RECENT EMPLOYER

Parent Company ____________________

Your division or subsidiary: ____________________

Location (City, State) ____________________

Business Phone if O.K. to use: ____________________

EDUCATION

Degrees (List)	Major Field	GPA	Year Degree Earned	College or University

POSITION DESIRED

____

EXPERIENCE

Present or Most Recent Position From: To: Title:

Duties and Accomplishments: Industry of Current Employer:

____

____

____

____

Reason for Change:

____

PREVIOUS POSITION:

Job Title: ____________________

Employer: __________ From: _____ To: _____ City: ________ State: ________

Division: __________ Type of Industry: __________ Salary: ________

Duties and Accomplishments: ____________________

COMPENSATION/PERSONAL INFORMATION

Years Experience	Base Salary	Commission	Bonus	Total Compensation	Asking Compensation	Min. Compensation

Date Available	I Will Travel ☐ Light ☐ Moderate ☐ Heavy	☐ I own my home. How long? ______ I rent my home/apt. ☐
☐ Employed ☐ Self-Employed ☐ Unemployed	☐ Married ☐ Single	Height______Weight______
Level of Security Clearance	☐ U.S. Citizen ☐ Non-U.S. Citizen	My identity may be released to: ☐ Any employer ☐ All but present employer

☐ WILL RELOCATE ☐ WILL NOT RELOCATE ☐ OTHER ____________________

EDN Databank

A DIVISION OF PLACEMENT SERVICES LTD., INC.

265 S. Main Street, Akron, OH 44308 216/762-0279

ENGINEERING OPPORTUNITIES . . .

After designing quality telecommunications products for over a quarter of a century, Transcom has become an established division of Alcatel. Our goal is to enhance our position as a major supplier of transmission equipment. As a result, Alcatel Transcom has the following opportunities available in new product development.

Software Engineering Manager

Will be responsible for the definition and implementation of identified telecommunications network management products. Use your software development skills in data communication protocols and digital transmission to provide leadership to a growing software development team. The successful candidate will have a BSCS/BSEE and 5+ years of experience (including 1 year at the project leader level). Experience using structured analysis and design to implement microprocessor-based products is highly desirable.

Hardware Design Engineers

Telecommunications Engineers with a solid background in both analog and digital circuit design are needed to develop sophisticated transmission products. Alcatel Transcom uses advanced VLSI and DSP technologies to optimize product performance and cost. A BSEE degree is required. DSP and/or T1 experience is a plus.

Software Engineers

Experienced software engineers are needed to contribute to the development of computer-based telecommunications products. These positions require a B.S. in Computer Science.The ideal candidates will have experience with Pascal and Intel 8086 assembly language and the *UNIX* operating system, with knowledge of structured analysis and design techniques. Experience in data communications and telecommunications is highly desirable.

ALCATEL TRANSCOM is an equal opportunity employer offering an excellent salary and benefit package. To apply, please forward your resume and salary expectations to:

Hugh B. McGettigan
ALCATEL TRANSCOM
1170 East Main Rd.
Portsmouth, RI 02871

ALCATEL

TRANSCOM

Where can you find small company advantages with big company backing?

Bell Aerospace TEXTRON.

We're a division of TEXTRON, one of the nation's largest defense contractors. And we're pioneering in the development of sophisticated inertial sensors and systems and radar/communication systems. Our size will offer you excellent opportunities to make significant personal contributions, enjoy lots of visibility and recognition, and involve yourself in a broad scope of work. We are looking for seasoned professionals for the following immediate position openings:

- **Proposal Manager**
- **Marketing Manager**
- **Quality Assurance Engineering Director**
- **Reliability Engineer**
- **Manufacturing Engineer – (Hybrid Assembly)**
- **Senior Structural Analysis Engineer**
- **Senior Logistics Engineer – (BSEE required)**
- **ADA Software Engineers**
- **Contract Administrator**
- **Hybrid Microelectronics Engineers**
- **Antennae Engineers**
- **CRT Display Systems Design Engineers**
- **Power Supply Design Engineers**

For prompt, confidential consideration, please send your resume and starting salary requirement to: David W. Pearl, Employment Manager, Bell Aerospace TEXTRON, Post Office Box One, Buffalo, New York 14240-0001.

Principals only, please.
An Equal Opportunity Employer, M/F/H/V.

Bell Aerospace TEXTRON
Division of Textron Inc.
Engineering Systems For Tomorrow.

Adjustable-Speed Drive Systems and Power Electronics Control Engineers

Achieving new levels of performance

One of GE Corporate R&D's objectives is to increase levels of drive systems performance through aggressive development and application of advanced power electronics and energy conversion technology.

The environment and the projects

As one of the world's leading laboratories linking basic research to applications, we offer a challenging, multi-disciplinary team environment. Accomplished professionals here contribute their expertise to key technologies.

- **Power semiconductor devices and packaging**
- **High-voltage integrated circuits and VLSI**
- **Power electronics circuits**
- **High-performance electrical machines**
- **Advanced control systems, including AI**
- **High-energy permanent magnets**

The opportunities for professionals

We have immediate staff level openings for Electrical Engineers (Ph.D. preferred). Your background should include some combination of the following:

- **Adjustable-speed drive systems analysis, simulation and controls synthesis**
- **Real-time digital control**
- **Advanced control theory (adaptive or optimal)**
- **Power electronic inverters, including power devices**
- **Electrical machine analysis and control, including PM synchronous, induction, and switched reluctance**
- **Aerospace electrical power system (e.g. VSCF's)**

Investigate the excellent salaries, benefits and prospects for growth we offer by sending your resume, in confidence, to Mr. Neff T. Dietrich, University Relations and Recruiting, Ref. 72C, GE Corporate Research and Development, P.O. Box 8, Schenectady, NY 12301.

GE Corporate Research and Development

An Equal Opportunity Employer

HAVING THE BEST TECHNOLOGY IS ONLY HALF THE BATTLE.

The Trojan Horse was a very progressive technological idea for its day — but what was it without those ingenious and determined soldiers inside? Nothing but an oversized wooden horse on wheels.

At Litton Data Systems we understand that it's the people behind technologies that make them work. And the people inside a company who make things happen.

Over twenty-five years of excellence in the design and manufacture of vital military C^3 systems mark our commitment to an entrepreneurial atmosphere that encourages our professionals to do what's necessary to conquer today's technologies.

If you're interested in joining a company with a classically simple strategy for success, consider one of the following positions:

SYSTEMS ENGINEERING

Due to a recently received major DoD multi-year production contract for mobile, modular C^3I Air Defense Systems for the Air Force and Marine Corps, we need strong systems engineers with a BSEE (Master's preferred) and 10 or more years' experience in developing international applications of these systems for tactical air operations. In addition, concepts for product improvement are needed for existing system configurations. Immediate openings exist for motivated, experienced systems engineers to lead the Engineering design process by performing requirements analyses, functional syntheses and hardware/software trade studies in the following areas:

- Tactical Air Operations
- Direct Air Support
- Command Operations Centers
- Forward Area Air Defense
- Artillery Fire Support
- Sensor Fusion
- Data Link Integration

PRODUCT DESIGN ENGINEERING

Electronic Design Standards Specialist

You will use your extensive engineering background to expand the electronic design standards and technology function in accordance with DoD Directive 4245.7M (Transition to Production) and NAVSO P.6071 (Best Practices). The successful candidate will possess a minimum 15 years' technical hands-on experience. Requires a BSEE (advanced degree desirable) and a working knowledge of digital and analog design, component technology and specifications, testability requirements and management techniques.

Automatic Test Equipment

Will work on division A.T.E. in Software development for unit level testers. Microprocessor Hardware design experience and familiarity with CMS2 programming language desirable. Requires 3-5 years' experience, BSCS/BSEE and the ability to follow a project through design, development and integration.

SOFTWARE/FIRMWARE ENGINEERING

- Requires a Sr. Software Engineer with experience on large military command and control systems. A background in CMS2 language and experience with communication data links such as TADIL-A, TADIL-B, TADIL-J, LINK-1 and ATDL-1 are highly desirable.
- Requires 5-10 years' experience in Assembly language programming for military systems and a minimum 5 years' experience in digital signal processing applications.
- Will be responsible for programming state-of-the-art digital and voice communication systems. Requires experience in the programming of the ZILOG Z80, INTEL 8748 and TI TMS 32020 microprocessors, and 3-5 years' experience in the development of communication firmware. A solid understanding of hardware design is necessary.

Above positions require a BS in Computer Science or Engineering.

- Will be responsible for contributing to the design and modeling of new algorithms. Requires an MS/PhD in Computer Science or Engineering and a minimum of 15 years' experience applying signal processing theory in the development of tracking systems.
- Will implement firmware for high speed digital database and impeded computer peripherals. Requires a BS in Computer Science, EE or Math and 3-5 years' experience in Assembly language, programming techniques and the use of the UNIX* Operating System.

Software Integration & Test

We need a qualified individual to fill a complex position in Air Defense & Communication Systems. The successful candidate will interpret customer specification requirements and participate in product upgrade design definitions and implement tasks. Will also prepare test documentation, perform system integration, identify and isolate problems, and conduct formal tests. This position requires excellent writing abilities. Experience in PC based software, particularly System Fault isolation and expert systems is desirable. BSEE or equivalent and 1-3 years' experience also required.

Jr. and Sr. Level Programmers

- Will generate PDL from detailed design documents, coding of programs in CMS2 and Assembly language and unit testing of the programs. Requires 3-8 years' software experience.

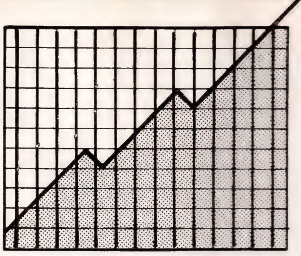
Please send your resume to: Employment, Dept. 709, 8000 Woodley Avenue, Van Nuys, CA 91409-7601.

Litton

Data Systems

Principals Only/Equal Opportunity Employer

*UNIX is a registered trademark of AT&T.



When you hire only the Best, the results aren't surprising.

Network Access Corporation is a pioneer in system integration technology with customers that include Bell and independent telephone companies. We are designing and producing innovative systems that provide advanced capabilities for central offices and communications networks. Our highly experienced key people are guiding the way with proven ideas and techniques in testing, manufacturing and quality assurance. We have doubled our staff during the last year and are seeking talented individuals to become part of our future:

DIGITAL TELEPHONY DESIGN ENGINEERS

A BSEE and 5 years electronic design experience is required with at least 3 years in digital telephony circuit design, including TI interface. Experience writing design documentation is also required. Knowledge of ISDN is a plus. Position is primarily responsible for design and development of board-level products.

SOFTWARE ENGINEERS

A BS degree in Electrical Engineering or Computer Science is a must for these positions in addition to 1-3 years in systems software development with 8088 assembly and "C" languages.

ISDN PRODUCT MANAGERS

These positions require 3-5 years development experience as well as 3-5 years in product management preferably with ISDN Data Communications.

HARDWARE ENGINEERS

3-5 years experience in design and development of telephony products combined with a BSEE is necessary. A background with Digital Signal processors and knowledge of BELLCORE requirements are essential.

SENIOR SOFTWARE ENGINEERS

BSEE or MSCS and 5 years systems software experience is required. Expertise with INTEL processors, assembly and "C" real time programming, and familiarity with RMX or RMK and MBII is also mandatory.

Our Dallas, Texas location has no state income tax and offers an ideal environment for both family and single living. Excellent housing, great schools, and abundant recreation are all close at hand. Network Access Corporation offers a competitive salary and company paid life, health, and dental insurance plus the opportunity to work with the best in an environment that encourages exceptional work by exceptional people. Qualified candidates are encouraged to send their resume to: **Network Access Corporation, Personnel, 1830 N. Greenville Avenue, Richardson, Texas 75081.** We are an equal opportunity employer.

NAC
NETWORK ACCESS CORPORATION
We're Ready For Your Future

CAREER OPPORTUNITIES

1988 Editorial Calendar and Planning Guide

EDN

Issue Date	Recruitment Deadline	Editorial Emphasis	EDN News
May 26	May 5	CAE, Software, Sensors/Transducers	Closing: Apr. 28 Mailing: May 19
June 9	May 19	CAE, Analog ICs, Test & Measurement	Closing: May 29 Mailing: June 16
June 23	June 2	Data Communications, DSP, Components	
July 7	June 14	Product Showcase—Vol. I, Power Sources, Software	Closing: June 23 Mailing: July 14
July 21	June 30	Product Showcase—Vol. II, CAE, Test & Measurement	
Aug. 4	July 14	Sensors & Transducers, Analog ICs, Graphics	Closing: July 21 Mailing: Aug. 11
Aug. 18	July 28	Military Electronics Special Issue, Displays, Military ICs	
Sept. 1	Aug. 11	Instruments, Op Amps, Computers & Peripherals	Closing: Sept. 1 Mailing: Sept. 22
Sept. 15	Aug. 25	Data Acquisition, Data Communications, Digital ICs	
Sept. 29	Sept. 8	DSP, Grahics, Optoelectronics	
Oct. 13	Sept. 22	Test & Measurement Special Issue, Instruments, Computers & Peripherals	Closing: Sept. 29 Mailing: Oct. 20
Oct. 27	Oct. 6	CAE, Computers & Peripherals, Integrated Circuits, Wescon '88 Show Preview	
Nov. 10	Oct. 20	Programmable Logic Devices, Integrated Circuits, Test & Measurements, Wescon '88 Show Issue	Closing: Oct. 27 Mailing: Nov. 17
Nov. 24	Nov. 3	Microprocessor Technology Directory Graphics, CAE	
Dec. 8	Nov. 16	Product Showcase—Vol. I, Power Sources, Software	Closing: Nov. 21 Mailing: Dec. 15
Dec. 22	Dec. 1	Product Showcase—Vol. II, Computers & Peripherals, Test & Measurement	

Call today for information:

East Coast: Janet O. Penn (201) 228-8610
West Coast: (714) 851-9422
National: Roberta Renard (201) 228-8602

PAPST

Choosing the right fan for your application is easy, when you choose PAPST. Simply because PAPST offers the broadest line of AC and DC tubeaxial fans in the world.

We also offer you some of the newest and most innovative. Like our new 48-volt DC MULTIFAN, our new sleeve bearing 80mm DC MULTIFAN, 6-inch DC fans with speed sensing or alarm circuitry, and our latest 25mm SLIM LINE series of AC fans.

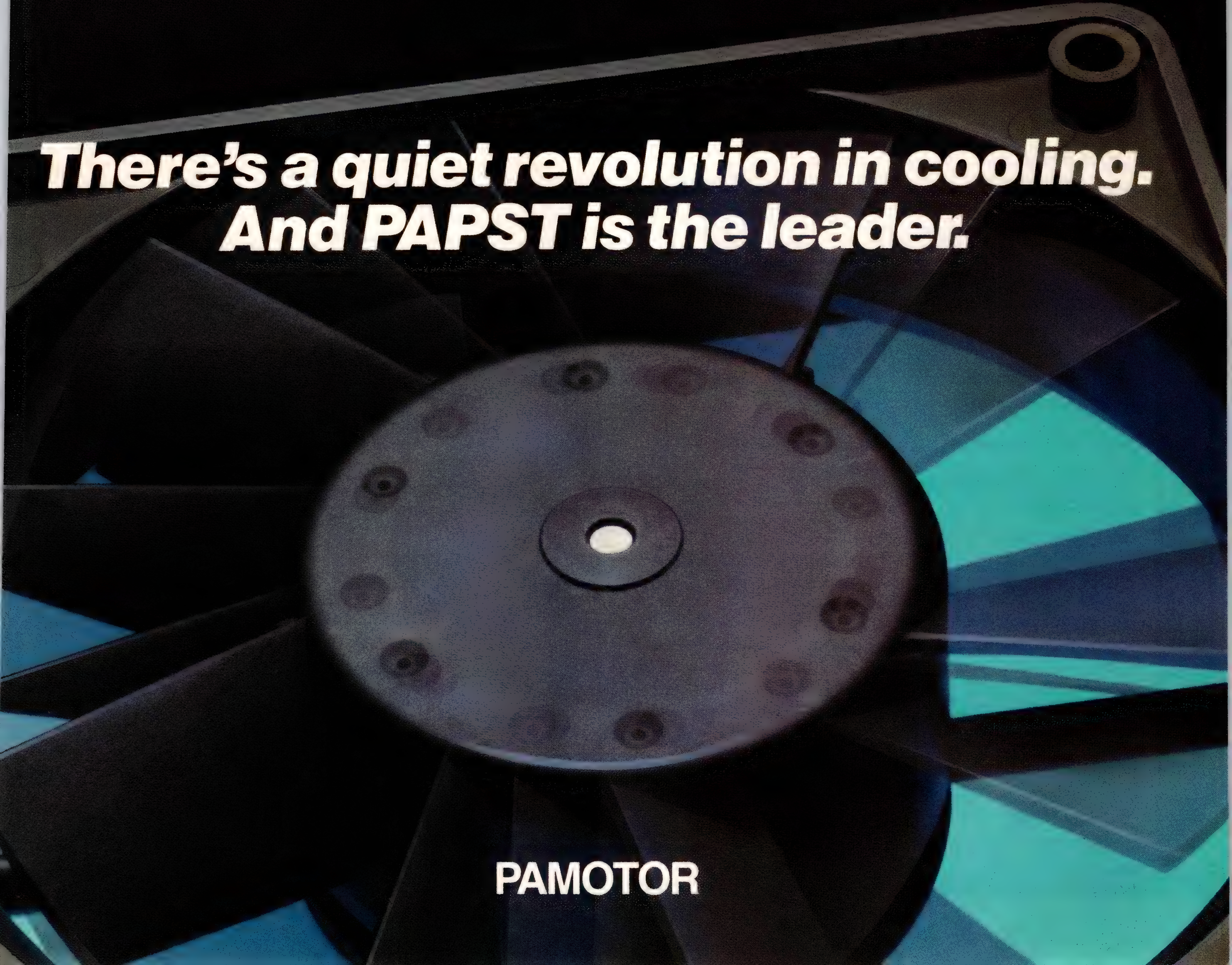
All PAPST fans are designed to deliver high reliability, low noise, and low power consumption. They all feature the PAPST concept of Mechatronics – electronic commands efficiently converted into direct mechanical movement. And they're all backed by one of the largest sales and technical support organizations in the country.

So if you don't want to waste a lot of time finding the wrong fan, spend a little time and call or write for our free catalog. It will help you find the fan you need. Fast.

PAPST MECHATRONIC CORPORATION,
Aquidneck Industrial Park,
Newport, RI 02840. (401) 849-8810
Telex 952092 1-800-551-6245
(Continental USA except for MA)
1-800-262-5226 (MA only)

CIRCLE NO 253

See us at ELECTRO, Booths 301-2



independent consultants constitute 10 to 15% of other professional societies' memberships. He hopes that SEER will give more IEEE members the opportunity to explore the idea of running their own consulting practices. "I hope that it lights a light for people who are interested in doing this kind of work." To provide further encouragement, the IEEE now sponsors a committee on entrepreneurship whose charter is to scout new sources of support and information for members who are considering starting small businesses.

The IEEE hopes that response to SEER will move along the same lines as it has to PEER, which, despite a slow start, now seems well established. The 1985 IEEE Member Opinion Survey, conducted one year after PEER's inception, turned up few respondents who had used the PEER service, and those surveyed exhibited mixed feelings about continuing it. In the last four years, however, PEER has remained active in a field in which many similar services have failed. The IEEE hopes that the 1988 member survey, due to be released this summer, will show steady support for the résumé database.

The IEEE is optimistic about the future of such services and is now working on a third addition to its roster. The Graduate Engineer Employment Registry, designed for use by students, is scheduled for introduction next year. **EDN**

How to participate in SEER

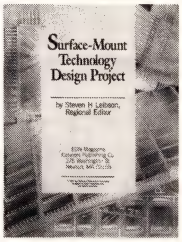
IEEE members interested in participating in SEER need to include a registration form along with their résumés. To obtain a registration blank, write to Career Technologies Corp, SEER Service Center, 138 Old River Rd, Andover, MA 01810, or phone the company at (617) 683-0098. (Members interested in contributing to PEER should follow the same procedure.)

SEER also puts priority assignments on line. Modem owners can access these assignments by calling the On-Line Network at (617) 263-3857, pressing the Return key, and entering the password *SEER*.

Article Interest Quotient
(Circle One)
High 512 Medium 513 Low 514

EDN REPRINTS

"Surface-Mount Technology Design Project" by Steve Leibson



Now you can order copies of EDN magazine's exclusive hands-on surface-mount design series. This 48-page, four-color reprint follows the progress of EDN editor Steve Leibson as he designs a 2 Mbyte memory board using surface-mount technology. Leibson takes you from his initial concept through to the finished working product, and includes typical problems you might encounter and objectively reports about both good and bad design decisions made along the way.

Don't miss this exclusive reprint that covers the newest design option that electronic engineers can use for designing innovative products. This latest reprint is yours for only $7.95 (UPS) and $10.95 (non-USA).

Mail coupon to:
EDN Reprints, EDN Magazine, Cahners Building, 275 Washington Street, Newton, MA 02158-1630

Please send ____ copies of *A Designer's Guide to Surface-Mount Technology* at $7.95 (UPS) or $10.95 (non-USA)*

Please print clearly. This is your mailing label.

Name ____
Title ____
Company ____
Address ____
City ____ State ____ Zip ____

*Check or money order made out to EDN REPRINTS must accompany each order. No COD.
Mass. residents add 5% sales tax.

EDN 042888

IEEE database service encourages entrepreneurial urges

Deborah Asbrand, *Associate Editor*

The latest addition to the IEEE's résumé-database service matches independent consultants with potential corporate clients. The IEEE intends the database to serve both members who maintain their own consulting practices and those who are retired but desire part-time work. But it also has a third—much larger—group in mind: industry-employed members who would like to try consulting.

The database is part of the IEEE's effort in recent years to lend more support to its members' entrepreneurial urges. One reason the organization formed the new résumé service, called the Self-Employed Engineers Registry (SEER), was to give business-minded members an outlet for making contacts and undertaking independent assignments without having to give up full-time corporate employment first.

SEER is based on the success of the Professional Engineering Employment Registry, known as PEER. The PEER service contains the résumés of job-seeking engineers and scientists from 30 technical societies. The database has more than 300 clients, who access the system through terminals installed in their own facilities. PEER began operating in 1984. Since then, it has become one of the most successful of the computerized résumé services.

But there are important differences between SEER and PEER. In the PEER files, individuals' names don't appear on the résumés. A company identifies candidates who interest them by using code numbers, which are assigned to the résumés by Career Technologies Corp, the Andover, MA, business that maintains the service. Career Technologies then contacts the individuals that a company has expressed interest in.

SEER, on the other hand, is not confidential. Individuals' names appear on the résumés that employers review. SEER still acts as an intermediary in the notification process, however: Employers who access the database contact SEER about a consultant they're interested in, and SEER then contacts the individual. Because of SEER's nonconfidentiality, the IEEE encourages engineers who plan to moonlight as consultants to obtain their employer's approval first.

Another difference between SEER and PEER is the format in which the participating engineers and scientists present their professional qualifications. Companies typically hire consultants who have the necessary experience in very specific technical areas. As a result, consultants' résumés often contain long passages of technical information. SEER allows its participants to abandon the traditional résumé structure and instead describe their engineering experience in detail.

Companies access SEER for a variety of reasons, according to Joe Stacey, president of Career Technologies. In many instances, employers need additional design assistance but can't afford to hire permanent, full-time technical professionals. Companies also hire independent consultants for short-term projects that don't warrant a full-time employee. Some corporate consulting needs are more unusual: Stacey says one company recently searched the database for an engineer to testify as an expert witness in a lawsuit.

Since SEER began operation (in September 1987), several hundred consultants have contributed résumés to the database. Stacey estimates that two dozen employers have used the service to date, and he says that although the level of interest in SEER will never equal that of PEER, he believes the market for SEER is sizable, particularly as the database grows. "More candidates result in more companies interested in using the service," he says.

Among the strongest supporters of SEER is Richard Backe, former chairman of the IEEE's Employment Assistance Committee and an active Region 2 member. Backe says that although the IEEE hasn't surveyed its members' opinions about starting businesses of their own, anecdotal evidence suggests that interest is strong. "There's been a hue and cry from people to gain some independence and try things from an entrepreneurial standpoint," he says.

The number of full-time consultants within the IEEE's ranks is small, only 5%. Yet Backe says that

Schroff®

OUR CABINETS WITHSTAND THE TOUGHEST TEST OF ALL – THE TEST OF TIME

See us at ELECTRO '88 Boston, Booths 195-196, 295-296

As a company dedicated to technical excellence, Schroff helps you prepare for the future. So you can be the first to take advantage of it.

For example, our Eurorack and Minirack cabinets are designed to help you meet changing market conditions. They're available in more than 45 different sizes, with a wide range of accessories and options, including RFI/EMI shielding, full glass doors (a Schroff exclusive), and much more. So chances are, you'll always be able to offer the features your customers are looking to buy.

Schroff Eurorack and Minirack cabinets are manufactured in the United States. They meet EIA, IEC, VDE and DIN standards. And they're made to deliver maximum rigidity and strength. As a result, you, and your customers, can be sure these cabinets will last as long on the job as they will in the market.

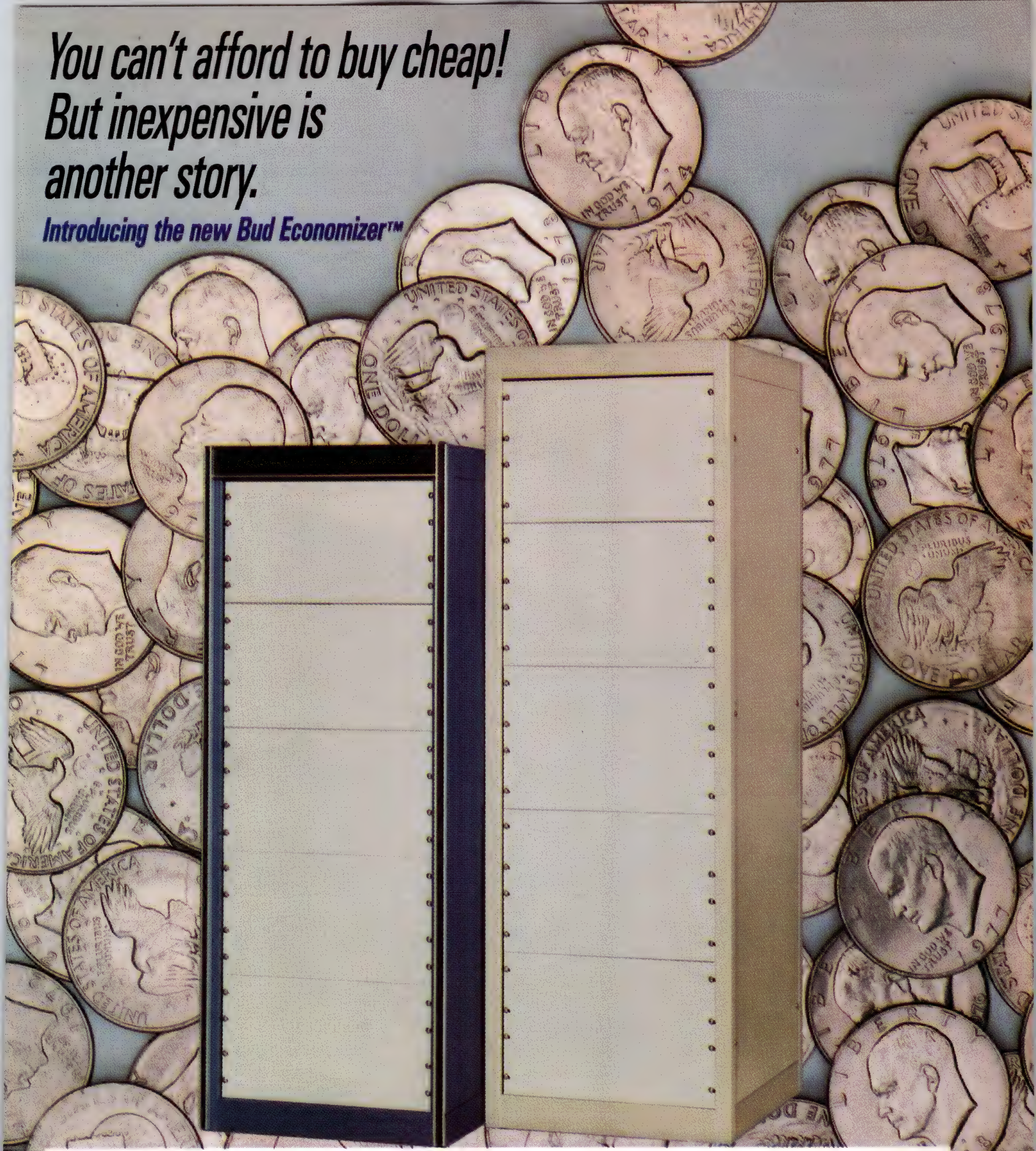
If your present cabinets can't pass the test of time the way Eurorack and Minirack can, it's time you looked at Schroff.

CIRCLE NO 94

Schroff Inc. · 170 Commerce Drive
Warwick, R. I. 02886 · Tel. (401) 732-3770
Telex 952175 · Telefax (401) 738-7988

Production in U.S., Europe and Japan

Our Representative for Canada:
A. C. Simmonds + Sons Ltd.
975 Dillingham Road · Tel. (416) 839 8041
Pickering Ontario L1W 3B2 · Tx 06 981 383



You can't afford to buy cheap! But inexpensive is another story.

Introducing the new Bud Economizer™

Check these features, then count your savings when you buy the new Economizer.™

- The stiffest welded frame in the Bud line at an incredible low price.
- Removable sides for easy access.
- Fully adjustable, top of the line mounting rails for fast accessory installation.
- 19″ equipment can also be mounted from rear.
- Optional Trim Kit as shown above on blue unit.
- Accepts the complete line of Bud standard accessory items.
- Stocked in all 5 heights and 3 depths.
- Available today from your local Bud Authorized Distributor.

BUD

Bud Industries, Inc.

BUD EAST, INC.
4605 East 355th Street
P.O. Box 431
Willoughby, Ohio 44094
(216) 946-3200
FAX 216-951-4015

BUD WEST, INC.
7733 West Olive Avenue
P.O. Box 1029
Peoria, Arizona 85345-0350
(602) 979-0300
FAX 602-878-5371

CIRCLE NO 95

EDN's CHARTER

EDN is written for professionals in the electronics industry who design, or manage the design of, products ranging from circuits to systems.

EDN provides accurate, detailed, and useful information about new technologies, products, and design techniques.

EDN covers new and developing technologies to inform its readers of practical design matters that will be of concern to them at once or in the near future.

EDN covers new products
- that are immediately or imminently available for purchase
- that have technical data specified in enough detail to permit practical application
- for which accurate price information is available.

EDN provides specific "how to" design information that our readers can use immediately. From time to time, EDN's technical editors undertake special "hands-on" projects that demonstrate our commitment to readers' needs for useful information.

EDN is written by engineers for engineers.

EDN
275 Washington St
Newton, MA 02158
(617) 964-3030

BUSINESS/CORPORATE STAFF

F Warren Dickson
Vice President/Publisher
Newton, MA 02158
(617) 964-3030
Telex 940573
Diann Siegel, Assistant

Peter D Coley
VP/Associate Publisher/
Advertising Sales Director
Newton, MA 02158
(617) 964-3030
Ora Dunbar, Assistant/Sales Coordinator

NEW ENGLAND
John Bartlett, Regional Manager
Chris Platt, Regional Manager
199 Wells Ave
Newton, MA 02159
(617) 964-3730

STAMFORD 06904
George Isbell, Regional Manager
8 Stamford Forum, Box 10277
(203) 328-2580

NEW YORK, NY 10011
Daniel J Rowland, Regional Manager
249 West 17th St
New York, NY 10011
(212)463-6419

PHILADELPHIA AREA
Steve Farkas, Regional Manager
487 Devon Park Dr
Suite 206
Wayne, PA 19087
(215) 293-1212

CHICAGO AREA
Clayton Ryder, Regional Manager
Randolph D King, Regional Manager
Cahners Plaza
1350 E Touhy Ave, Box 5080
Des Plaines, IL 60017
(312) 635-8800

DENVER 80206
John Huff, Regional Manager
44 Cook St
(303) 388-4511

DALLAS 75243
Don Ward, Regional Manager
9330 LBJ Freeway
Suite 1060
(214) 644-3683

SAN JOSE 95128
Walt Patstone, Regional Manager
Bill Klanke, Regional Manager
Philip J Branon, Regional Manager
James W Graham, Regional Manager
3031 Tisch Way, Suite 100
(408) 243-8838

LOS ANGELES 90064
Charles J Stillman, Jr
Regional Manager
12233 W Olympic Blvd
(213) 826-5818

**ORANGE COUNTY/
SAN DIEGO 92715**
Jim McErlean, Regional Manager
18818 Teller Ave, Suite 170
Irvine, CA
(714) 851-9422

PORTLAND, OREGON 97221
Pat Dakin, Regional Manager
Walt Patstone, Regional Manager
1750 SW Skyline Blvd, Box 6
(503) 297-3382

UNITED KINGDOM/BENELUX
Jan Dawson, Regional Manager
27 Paul St
London EC2A 4JU UK
44 01-628 7030
Telex: 914911; FAX: 01-628 5984

SCANDINAVIA
Stuart Smith
27 Paul St
London EC2A 4JU UK
01-628 7030
Telex: 914911; FAX: 01-628 5984

FRANCE/ITALY/SPAIN
Alasdair Melville
27 Paul St
London EC2A 4JU UK
01-628 7030
Telex: 914911; FAX: 01-628 5984

WEST GERMANY/SWITZERLAND/AUSTRIA
Wolfgang Richter
Sudring 53
7240 Horb/Neckar
West Germany
49-7451-7828; TX: 765450

ISRAEL
Igal Elan
Elan Marketing Group
13 Haifa St, Box 33439
Tel-Aviv, Israel
Tel: 972-3-268020
TX: 341667

EASTERN BLOC
Uwe Kretzschmar
27 Paul St
London EC2A 4JU UK
01-628 7030
Telex: 914911; FAX: 01-628 5984

FAR EAST
Ed Schrader, General Manager
18818 Teller Ave, Suite 170
Irvine, CA 92715
(714) 851-9422; Telex: 183653

TOKYO 160
Kaoru Hara
Dynaco International Inc
Suite 1003, Sun-Palace Shinjuku
8-12-1 Nishishinjuku, Shinjuku-ku
Tokyo 160, Japan
Tel: (03) 366-8301
Telex: J2322609 DYNACO

TAIWAN
Acteam International
Marketing Corp
6F, No 43, Lane 13
Kwang Fu South Rd
Mailing Box 18-91
Taipei, Taiwan ROC
760-6209 or 760-6210
Telex: 29809
FAX: (02) 7604784

KOREA
BK International
Won Chang Bldg, 3rd Floor 26-3
Yoido-dong, Youngdungpo-ku
Seoul 150, Korea
Tel: 785-6665
Fax: 784-1915
Telex: K32487 BIZKOR

PRODUCT MART
Joanne Dorian, Manager
249 West 17th St
New York, NY 10011
(212) 463-6415

**CAREER OPPORTUNITIES/
CAREER NEWS**
Roberta Renard
National Sales Manager
103 Eisenhower Parkway
Roseland, NJ 07068
(201) 228-8602

Janet O Penn
Eastern Sales Manager
103 Eisenhower Parkway
Roseland, NJ 07068
(201) 228-8610

Western Sales Manager
18818 Teller Ave
Suite 170
Irvine, CA 92715
(714) 851-9422

Maria Cubas
Production Assistant
(201) 228-8608

Susan M Campanella, *Advertising/Contracts Coordinator*
Nan Coulter, *Advertising/Contracts Coordinator*
(617) 964-3030

**William Platt, Sr, Vice President, Reed Publishing USA
Cahners Magazine Division**
Terry McDermott, President, Cahners Publishing Co
Frank Sibley, Group Vice President, Electronics/Computers
Tom Dellamaria, VP/Production & Manufacturing

Circulation
Denver, CO: (303) 388-4511
Sherri Gronli, Group Manager
Eric Schmierer, Manager

Reprints of EDN articles are available on a custom printing basis at reasonable prices in quantities of 500 or more. For an exact quote, contact Joanne R Westphal, Cahners Reprint Service, Cahners Plaza, 1350 E Touhy Ave, Box 5080, Des Plaines, IL 60018. Phone (312) 635-8800.

0 to 60 in 5 seconds

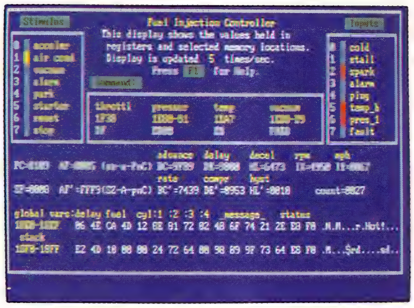
with new UniLab 8620 analyzer-emulator.

■ 64Kbytes from hard disk in 5 seconds. That's moving. But today you've got to be fast just to stay in the race for better microprocessor designs.

■ The secret is a new, high-speed parallel interface: the Orion bus. Which zips data between your PC/AT and the 8620 analyzer-emulator, breaking the RS-232 bottleneck.

■ The 8620 with O-bus gives you complete program diagnosis — and solutions — in real time. For more than 150 different microprocessors. Using **the same command set** environment.

■ A generous 2730 trace-cycle buffer with selective filtering lets you cut through the clutter and display just the traces you wish. And you get 1μsec resolution in program time measurement. Plus continuous InSight monitoring of your program's key functions as they are performed.



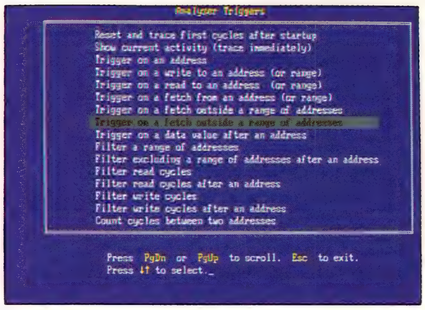
```
Fuel Injection Controller
This display shows the values held in
 registers and selected memory locations.
 Display is updated 5 times/sec.
         Press F1 for Help.
```

InSight Display. InSight blends analyzer-emulator techniques to give you continuous, real time monitoring of key processor functions. And still services user interrupts. It displays changing register contents, I/O lines, ports, user-defined memory windows. With your own labels.

■ On top of that, you get UniLab's trademark ability to debug by symptom, not just by breakpoint and single step. And, to help you complete the job on time, on the spot, a stimulus generator and EPROM programmer are included.

■ Ease of use, another Orion trademark, is also built in. So you have all the familiar features and formats you're used to working with. It doesn't matter if your project is a single chip controller or complex 16-bit microprocessor, the 8620 is the top price/performance analyzer-emulator that does it all. At just $4380. With processor Personality Paks typically $550 each.

■ UniLab 8620. Fast-lane debugging that gets you to market quicker.



```
                    Analyzer Triggers
        Reset and trace first cycles after startup
        Show current activity (trace immediately)
        Trigger on an address
        Trigger on a write to an address (or range)
        Trigger on a read to an address  (or range)
        Trigger on a fetch from an address (or range)
        Trigger on a fetch outside a range of addresses
        Trigger on a fetch outside a range of addresses
        Trigger on a data value after an address
        Filter a range of addresses
        Filter excluding a range of addresses after an address
        Filter read cycles
        Filter read cycles after an address
        Filter write cycles
        Filter write cycles after an address
        Count cycles between two addresses

          Press PgDn or PgUp to scroll.  Esc to exit.
          Press ↓↑ to select._
```

Analyzer Triggers. Commonly used triggers can be selected quickly from a list of standard and user-defined triggers.

Call toll-free: 800/245-8500.
In CA: 415/361-8883

ORION
INSTRUMENTS

See us at Electro Booth 2741-45

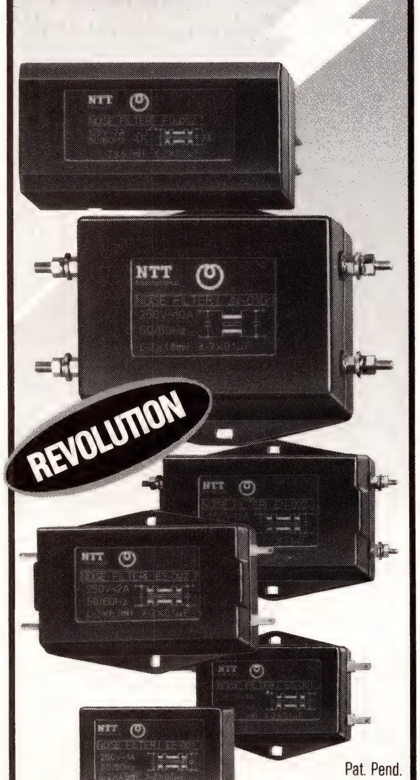
702 Marshall St., Redwood City, CA 94063
TLX 530942 FAX 415/361-8970
Computer Integrated Instrumentation

CIRCLE NO 96

NTT GROUNDLESS POWER-LINE EMI NOISE FILTER

NO GROUNDING.
NO TRIAL AND ERROR.
NO WORRIES.

NTT'S REVOLUTIONARY SUPER-ATTENUATING "GROUNDLESS" POWER-LINE NOISE FILTER!



NTT's advanced Power line Noise Filters ensure high attenuation in broad bands — without grounding! Trial-and-error countermeasures against noise are no longer necessary. Nor is worry about the protection of ungrounded factory, office and home electronic equipment. Consult NTT now for:

*Guaranteed broad-band, high attenuation in lines from 0.15 — 50MHz.
*Lightning-surge-protective effect.
*High voltage pulse noise attenuation.
*Significant cost saving
Send now for literature and specifications:

NTT Nippon Telegraph & Telephone
International

NTT International Corporation
8F, 21st Mori-Building, 4-33 Roppongi 1-chome,
Minato-ku, Tokyo 106, JAPAN
Telephone: Domestic: 03-584-9962
International: 81-3-584--9962
Facsimile: 81-3-584-9977
Telex: 2425454 NTTIA J

DISTRIBUTOR WANTED!!

CIRCLE NO 69

nators; surge protectors; computer and printer switches; data, bulk-data, and personal-computer cables; and twin-axial interface products.

Electro Standards Laboratory Inc, Box 9144, Providence, RI 02940.

Circle No 447

How to find video digital signals with an MCP scope

The application note *See Digital Controlled Video Signals and Make Precision Timing Measurements Using the 2467 Portable Scope (38W-6797)* explores a wide range of measurement techniques from basic video to digital/frame-rate timing. It reports on the measurement of pulses as narrow as 50 nsec and explains how you can see them in full detail on a microchannel-plate CRT scope. The note provides several illustrations of this waveform-viewing feature.

Tektronix Inc, Box 1700, Beaverton, OR 97077.

Circle No 448

MEMORY

POINTERS 3

The Workstation Wars
... a Memory Perspective

New from Clearpoint

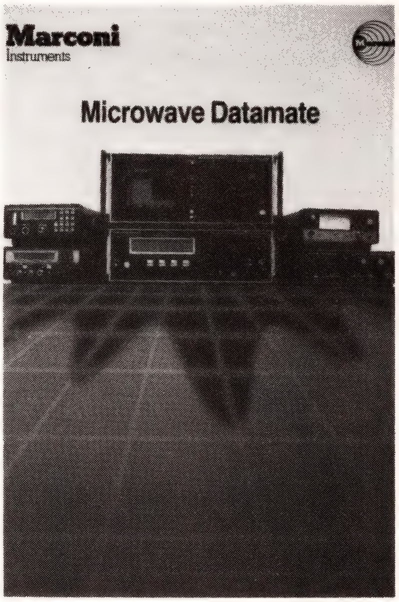
PCs? Real Contenders?

Monograph series reports on computer memory

Memory Pointers, the vendor's newsletter, analyzes current technical developments in the add-in computer-memory market and analyzes the various computer memory offerings of Apollo, Sun, Hewlett-Packard and others. It provides regular features such as a question and answer column and a new-product section.

Clearpoint Inc, 99 South St, Hopkinton, MA 01748.

Circle No 449



Marconi
Instruments

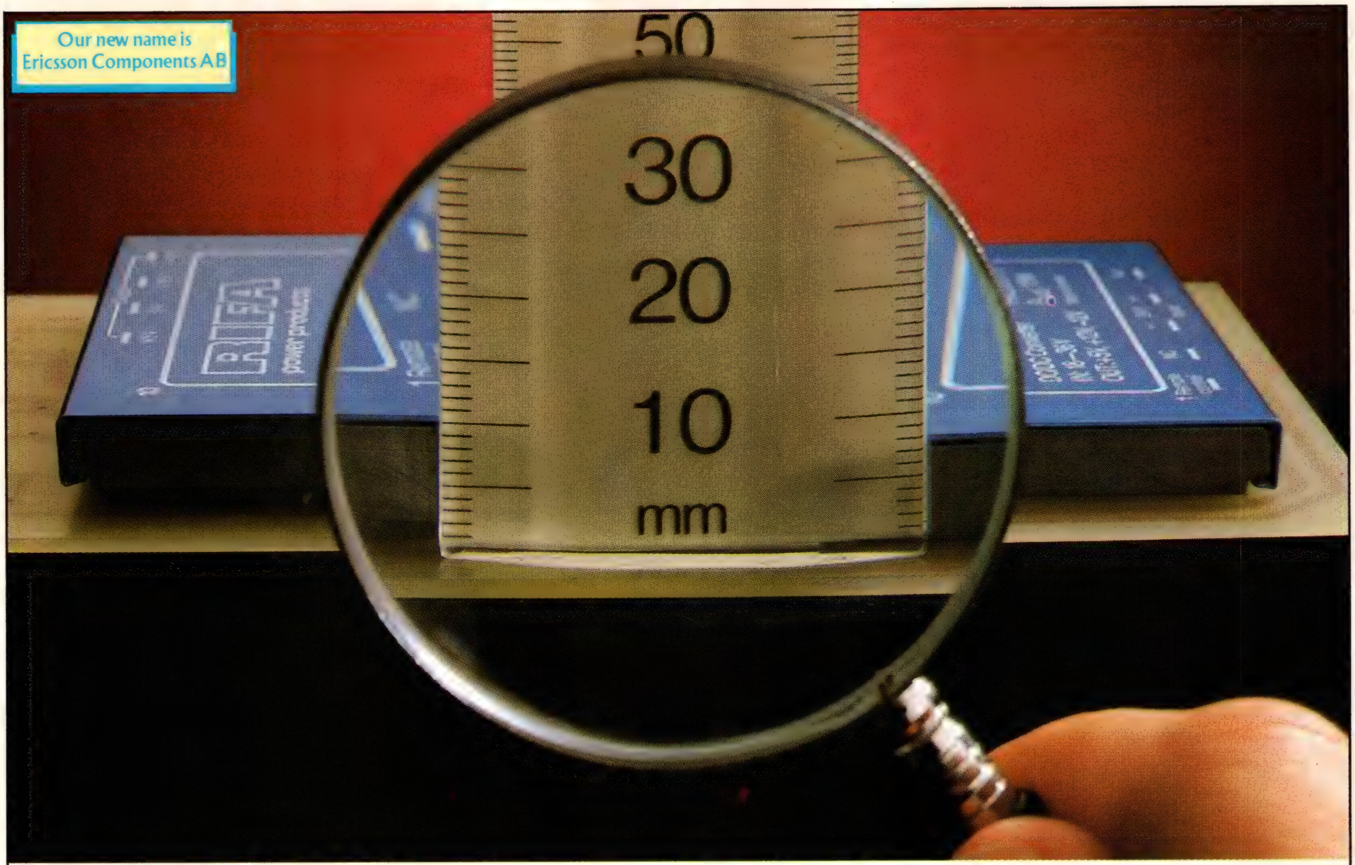
Microwave Datamate

Reference for microwave and RF engineers

The 61-pg brochure *Microwave Datamate* deals with topics such as microwave applications by frequency, waveguide parameters, connections, transmission lines, power measurement, and scalar network analyzers. Following the first section on general information is an explanation of satellite and terrestrial telecommunications systems. Another section examines waveguide parameters and has a waveguide data chart. Among the subjects highlighted in the final section are IEEE-488 programming, a status and message-exchange overview, S-parameters and transformations, and scattering parameter relationships.

Marconi Instruments, 3 Pearl Ct, Allendale, NJ 07401.

Circle No 450



High performance power, in a low profile package

Ericsson's new triple output, 15 Watt DC/DC converter is only 8·5mm high with In-Card(TM) mounting!

When you need high performance and a low profile in a DC/DC converter, Ericsson's new 15W PKC series has the answer.

The PKC's advanced mechanical design offers two mounting options, Using conventional "On-Card" pcb mounting results in a height of 0·42" (10·7mm).

Where profile is critical our In-Card(TM) mounting provides the unique capability of recessing the supply into the pcb providing a height of 0·33" (8·5mm)!

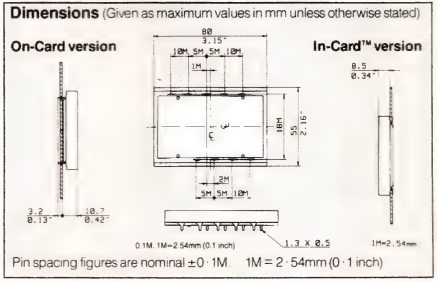
Allowing inputs of 24V (18-36V) and 48V (36-72V) the PKC series provides 5, 12 and 15V dc outputs in single, dual and triple output configurations. A high reliability magnetic feed back loop ensures that all outputs are regulated to within 2·5%. Each model is fully isolated to 500V dc and all outputs are overvoltage protected.

Advanced technology, including the use of highly automated surface mount manufacturing and 300kHz switching frequency results in the PKC's exceptional MTBF of over 200 years.

SMD components are assembled onto a thick film ceramic substrate to give excellent thermal characteristics. As a result, efficiency is 85% and the unit operates without derating over the temperature range of −45°C to +85°C!

The PKC takes up no more pcb space than a credit card.

Choose from On-Card or In-Card(TM) mounting.


Dimensions (Given as maximum values in mm unless otherwise stated)
On-Card version
In-Card™ version
80
3.15"
10M
5M
5M
10M
1M
18M
55
2.16"
2M
5M
5M
10M
3.2
0.13"
10.7
0.42"
8.5
0.34"
1.3 X 0.5
0.1M, 1M=2.54mm (0.1 inch)
1M=2.54mm
Pin spacing figures are nominal ±0·1M. 1M = 2·54mm (0·1 inch)

No extra components, filters or heatsinks are required to meet VDE, FCC or CISPR regulations with respect to RFI specifications or high temperature environments.

Paralleling units for higher output requirements or redundancy configurations is easily accomplished by a simple connection.

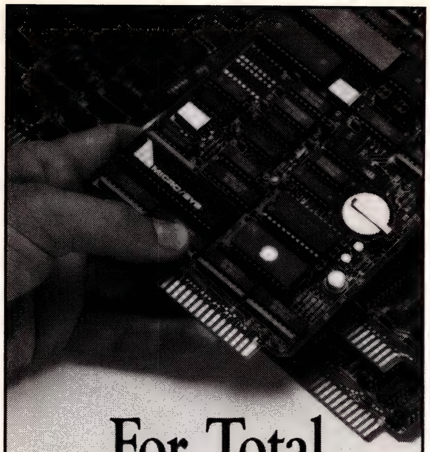
To find out more about the world's most advanced 15W DC/DC converter, contact Ericsson today.

ERICSSON

RIFA Inc.
PO Box 853904, RICHARDSON,
TEXAS 75085-3904 USA
Tel: 214 480-8300 Fax: 214 680-1059
Telex: 735389 ERICS RCHN

Ericsson Components AB
Power Products, S-16481 KISTA-STOCKHOLM,
SWEDEN
Tel: +46 8 757 50 00 Fax: +46 8 757 48 84
Telex: 109 48 POWERI S

CIRCLE NO 97



For Total STD BUS Networking Support...

Choose BITBUS from Micro/sys

When you need to link STD BUS systems into a real-time industrial network, you need support. The kind of support you get from Micro/sys' STD/mux family.

Products and engineering assistance that help you implement the industrial network chosen by Intel and DEC: BITBUS.

BITBUS gives you fast, highly reliable operation on a low cost twisted pair interconnect. Your options are open with PC, VAX, STD or other network hosts.

And Micro/sys BITBUS support eases your development. Message and file transfer functions. ROM'able C and BASIC compilers with network support. Host PC software drivers. Even turnkey, preprogrammed STD card sets that give a computer total control over 250 remote STD BUS backplanes.

Call or write today to receive details. Then choose BITBUS from Micro/sys.

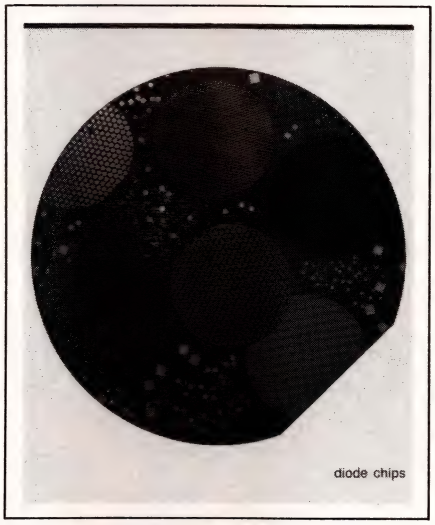
STD/mux™ Micro/sys
DEC, VAX™ Digital Equipment
BITBUS™ Intel

MICRO/SYS
1011 Grand Central Ave.
Glendale, CA 91201
(818) 244-4600

series incorporate specifications, dimensional drawings, and photographs.

Methode Electronics Inc, Connector Div, 7447 W Wilson Ave, Chicago, IL 60656.

Circle No 444



Brochure deals with diodes

The 12-pg brochure *Diode Chips* outlines unencapsulated die and surveys die geometries, types, and metallizations. Specific chips are available through the level equivalent of the Joint Army-Navy Specification. Devices offered in chip form include zener diodes, rectifiers, transient suppressors, and temperature-compensated chips.

Microsemi Corp, 2830 S Fairview St, Santa Ana, CA 92704.

Circle No 445

How to build programmable gain amplifiers

ANALOG DEVICES

APPLICATION NOTE

ONE TECHNOLOGY WAY • P.O. BOX 9106 • NORWOOD, MASSACHUSETTS 02062-9106 • 617/329-4700

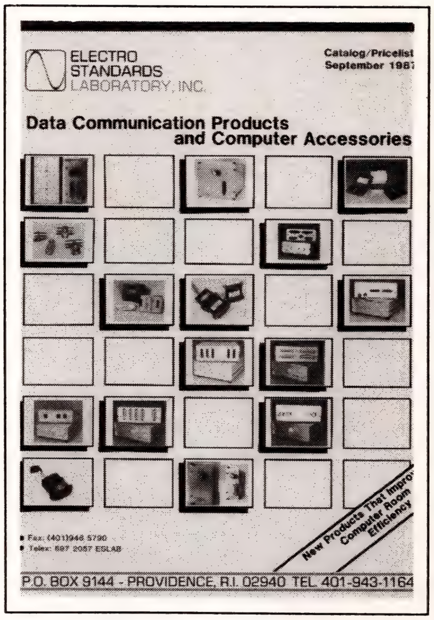
CMOS DACs and Op Amps Combine to Build Programmable Gain Amplifiers Part II

by John Wynne

The 12-pg application note, *CMOS DACs and Op Amps Combine to Build Programmable Gain Amplifiers, Part II* examines the performance of dual-CMOS DACs as gain-determining elements in a programmable-gain-amplifier (PGA) system. It discusses how you can achieve greater accuracy over a wide dynamic range, using a dual-DAC circuit. Some of the subjects in the note include basic equations for a dual-DAC PGA, comparing errors, small-signal bandwidth, and dynamic gain errors. Equations, circuit diagrams, and tables illustrate the text.

Analog Devices, Literature Center, 70 Shawmut Rd, Canton, MA 02021.

Circle No 446



ELECTRO STANDARDS LABORATORY, INC.

Catalog/Pricelist
September 1987

Data Communication Products and Computer Accessories

• Fax: (401)946 5790
• Telex: 697 2057 ESLAB

New Products That Improve Computer Room Efficiency

P.O. BOX 9144 - PROVIDENCE, R.I. 02940 TEL 401-943-1164

Computer and datacomm products categorized

This product catalog can help you plan a new network installation, or maintain or expand existing networks. It contains the vendor's line of RS-232C breakout boxes; cable adapters; line drivers; modem elimi-

Who's got the button?

Nobody, but nobody, offers or delivers more rechargeable button cells and batteries than Varta. There are important reasons why!

This year, 1988, Varta celebrates its 100th year in manufacturing batteries of all types. In the '50's we led the world in commercialization of NiCd batteries.

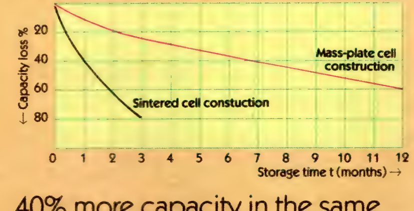
100 years
1888 1988
VARTA

We invented the mass-plate cell construction which excels over competing sintered nickel-cadmium cells in key ways that improve your product performance.

In stand-by at ambient temperatures, our mass-plate button cells retain 60% capacity after 12 months versus about three months for sintered NiCd cells, because they have much lower internal losses. Similarly, they require much lower recharging rates, as low as 1mA (C/100) versus 4-7mA for competition, so charging power and circuitry will be minimized.

Varta mass-plate button cells and batteries usually take significantly less space—or let you put up to 40% more capacity in the same space. They can be stored in any state of charge for over five years without significant loss of performance. In addition, extra high temperature ratings and UL listings are available in key sizes.

Self discharge comparison at 20°C



Yet, with all their advantages, Varta mass-plate button cells and batteries usually cost less than comparable sintered-type cells. Mass-plate button cell capacities range from 4 mAh to 1000 mAh and a wide variety of flat or stacked batteries can be assembled from them.

For rechargeable applications above 1000 mAh, Varta also offers a complete line of NiCd cells and batteries highly competitive in performance and cost.

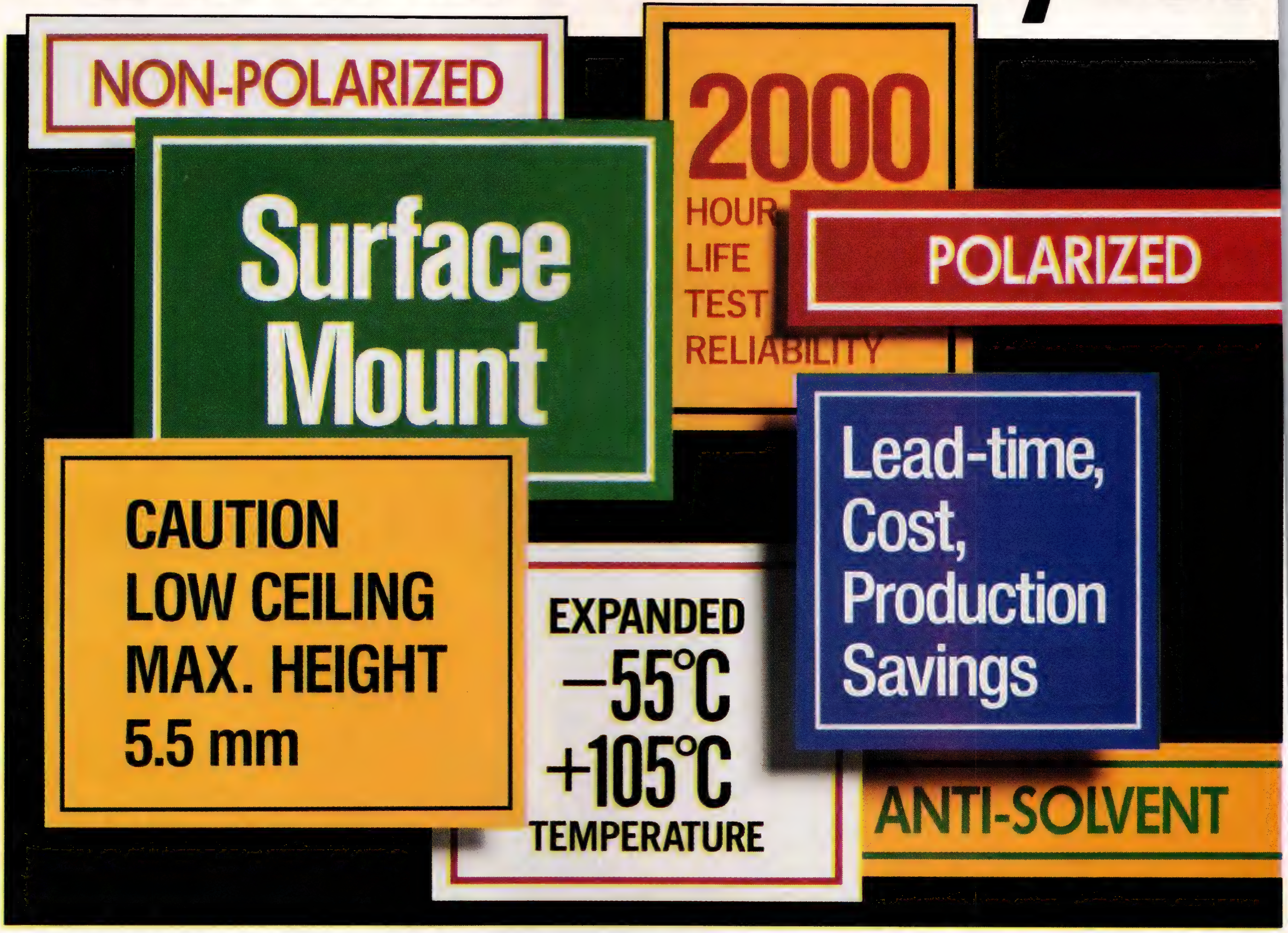
For an introduction to Varta's world-leading line of rechargeable button cells and batteries, please ask for "Who's Got The Button". Call 1-800-431-2504, Ext. 260, or write below.

VARTA

VARTA Batterie AG, Am Leineufer 51, D-3000 Hannover 21, West Germany, Tel. (49) 0511/79031
VARTA Batteries, Inc., 300 Executive Blvd., Elmsford, NY 10523, USA, Tel. 1-800-431-2504, Ext. 260
VARTA Batteries Pte Ltd., 1646 Bedok North P.O. Box 55, Singapore 9146, Tel. (65) 241-2633

CIRCLE NO 235

Aluminum Electrolytics


NON-POLARIZED
Surface Mount
2000 HOUR LIFE TEST RELIABILITY
POLARIZED
CAUTION LOW CEILING MAX. HEIGHT 5.5 mm
EXPANDED −55°C +105°C TEMPERATURE
Lead-time, Cost, Production Savings
ANTI-SOLVENT

All signs point to Nichicon surface mount electrolytics.

In surface mount capacitors, success breeds success.

And with four new surface mount electrolytic capacitor series ready to help your products meet their marketing window—on budget, all signs now point to Nichicon.

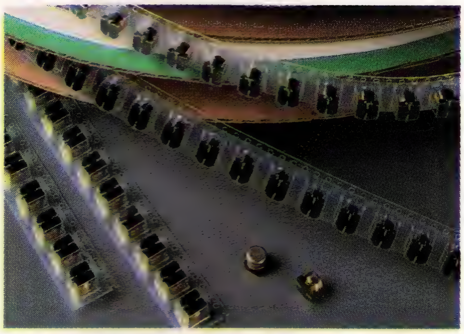
Save time. Save space. Save money.

Who isn't under pressure these days to reduce costs?

Well now you can, without sacrificing performance, when you design your new products or replace comparable tantalum capacitors with one of our new surface mount electrolytics.

More Nichicon advantages.

Your real bottom line though is still capacitor performance. And with four tantalum equivalent Nichicon surface mount electrolytic capacitor series to choose from, your chances of finding your capacitor choice are better than ever.



SERIES	FEATURE
UP	Non-polarized/ − 40°C∼ + 85°C 6.3∼50V/0.1∼47μF
WX	2,000 hour life/5.5mm max. ht. 4∼50V/0.1∼220μF
UT	− 55°C∼ + 105°C 4∼50V/0.1∼100μF
MX	2,000 hour life/6.3mm max. ht. 4∼50V/0.1∼220μF

Of course, each series is carrier-taped and reeled and features Nichicon's anti-solvent design.

For your free Nichicon Surface Mount Electrolytic Capacitor data sheet or more information, call one of our customer service representatives at (312) 843-7500. Or, call your local Nichicon representative or distributor.

nichicon®
The capacitor choice.

927 E. State Parkway • Schaumburg, IL 60173 • (312) 843-7500

One good idea after another.

CIRCLE NO 36

© Nichicon (America) Corporation 1987

FLUKE AND PHILIPS – THE GLOBAL ALLIANCE IN TEST & MEASUREMENT

FLUKE®

PHILIPS

Smart performance, smart price

PM 3350 – Philips' new-generation DSO – brings real state-of-the-art performance to mid-price oscilloscopes. With a high 100 Ms/s sampling rate on both channels simultaneously, to capture fast signal phenomena with high resolution. Plus triggering over a wide 100 MHz bandwidth, and smart auto-triggering to eliminate manual adjustment.

Cursor measurement on stored signals couldn't be simpler. Just place the cursors, and read the values out directly. Functions include voltage, time and period, risetime and frequency. Or for closer examination of signal details, the 'restart' function zooms-in instantly on any region of interest defined by the cursors.

PM 3350's smart operating features make the power of digital storage easier than ever to apply. Like an ergonomic front panel layout, and menu-driven softkeys. Clear LCD panels for at-a-glance readouts. And the multi-parameter Philips Autoset to catch every signal optimally.

But best of all, PM 3350 is a very economic instrument. With a smart price that matches its smart performance.

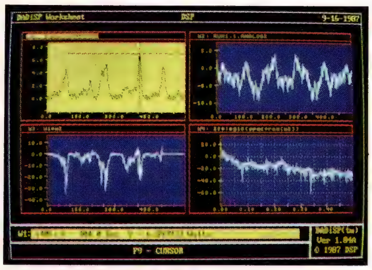
For further information, call your local supplier:
Austria* (222) 629141, **Belgium** (2) 5256692/94, **Denmark*** (1) 572222, **Finland*** (0) 5257225, **France** (1) 49428080, **Germany** (561) 5010, **Great Britain** (223) 358866, **Ireland** (1) 952501, **Italy*** (39) 3635240/8/9, **Netherlands** (13) 352455, **Norway*** (2) 680200, **Portugal*** (1) 683121, **Spain*** (1) 4042200, **Sweden** (8) 7821800, **Switzerland** (1) 4882211.
***For Philips products only.**
For countries not listed, write to: Philips I&E, T&M Department, Building HKF, 5600 MD Eindhoven, The Netherlands.

ADVANCED TECHNOLOGY MADE TO MEASURE

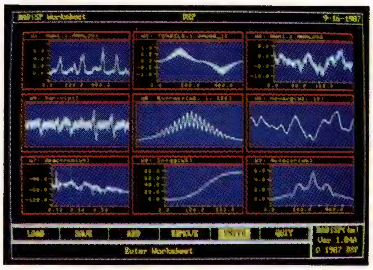
PHILIPS

DADiSP...

Serious Signal Analysis
The Way You Always
Pictured It!



Make Waves...



make Sense...

the First Spreadsheet designed exclusively for Scientists and Engineers.

Over 150 functions for displaying and analyzing waveforms makes sophisticated signal processing as easy as typing a name. Run external data acquisition software, or *your own analysis programs;* create new functions with DADiSP *Macros;* and, talk to your instruments with **DADiSP-488.**

make a Call.

(617) 577-1133

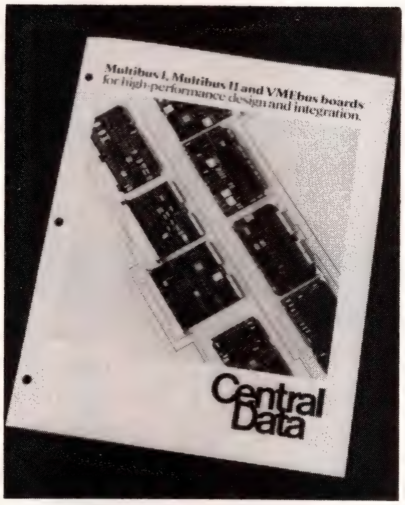
Order our $20 Interactive Demo Disk. Ask about DADiSP for IBM-PC/XT/AT, DEC MicroVAX, HP9000, Masscomp 5000, and Sun Workstations. For further information write DSP Development Corporation, One Kendall Square, Cambridge, MA 02139, (617) 577-1133

DSP
Development
Corporation

use of combiners, receiver multicouplers, duplexers, antennas, and cable.

Celwave RF, Div of Radio Frequency Systems Inc, Route 79, Marlboro, NJ 07746.

Circle No 441


Multibus I, Multibus II and VMEbus boards for high-performance design and integration.
Central Data

Multibus I and II boards cataloged

This 35-pg catalog covers a complete line of Multibus I boards and accessories, and four new Multibus II products. It contains photographs, descriptions, and specifications for more than 30 Multibus I, Multibus II, and VME Bus board-level products. It describes a Multibus II communications controller, a SCSI and floppy controller, an SBX single-board computer, and an intelligent prototype board.

Central Data Corp, 1602 Newton Dr, Champaign, Il 61821.

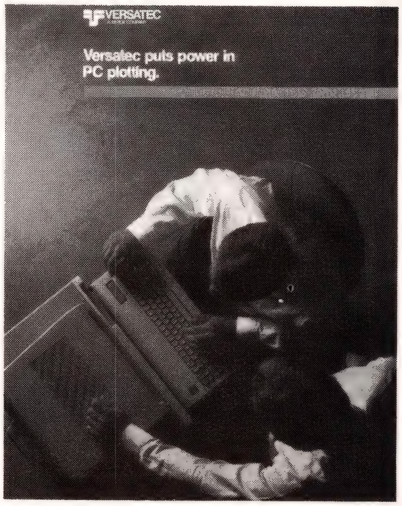
Circle No 442

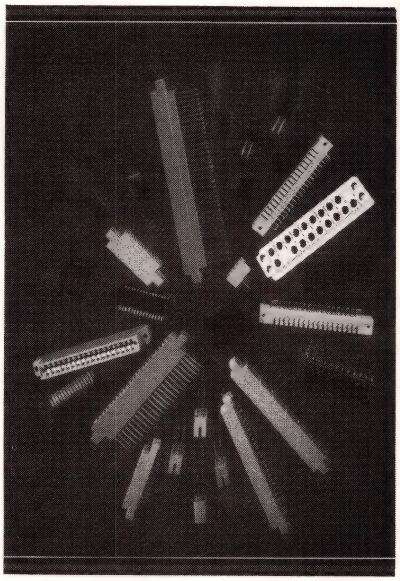
How to connect plotters to personal computers

The 4-color brochure, *Versatec puts power in personal-computer plotting,* tells you how to receive hard copy information on your IBM PC or compatible, or your Macintosh personal computer. Its diagrams show the configurations, including software, interface or rasterizer, and plotter. Besides discussing the advantages of using electrostatic and thermal transfer plotters, the folder also contains a product table to help you select the right plotter for speed, size, and high-quality output.

Versatec, 2710 Walsh Ave, Santa Clara, CA 95051.

Circle No 443





Booklet features card-edge connectors

The 36-pg catalog *Card Edge Connectors* focuses on the vendor's card-edge-connector series that come on 0.05- to 0.336-in. contact centers with wire-wrap, dip-solder, solder-eye, and right-angle terminations. The descriptions of the 56 connector

Continued on pg 344

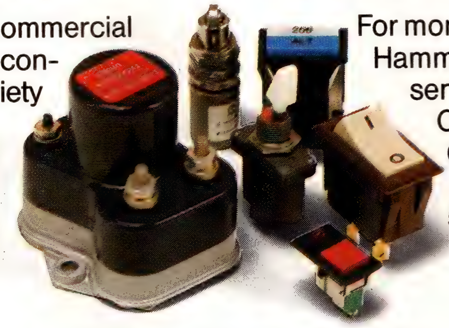
CIRCLE NO 67

Cutler-Hammer® aerospace switches thrive on punishment.

Pick an application—your toughest application. That's where you'll want to use one of these remarkably rugged Mil-Spec switches.

From applications on business/commercial aircraft, heavy-duty vehicles and construction equipment, to a wide variety of military applications—these switches survive the harshest environments.

Choose from a broad line of sealed and unsealed switch types. Each backed by extensive R&D and supported by a solid, service-oriented sales and distributor network.



For more information contact your Cutler-Hammer Sales Office or Distributor. Or send for our complete catalog. Eaton Corporation, Aerospace & Commercial Controls Division, 4201 N. 27th St., Milwaukee, WI 53216. Or call 414-449-7487.

EATON

Aerospace, Commercial, Miniature, Illuminated Switches and Relays.

CIRCLE NO 238

VISIT US AT THE ELECTRO SHOW, BOOTHS 1309 & 1311

◆
NEW FROM
ACADEMIC
PRESS
◆

Professional
and
Technical
Series

Academic Press is launching a new series of books for high technology professionals. To write these books, we are seeking authors in such fields as:

- 32-bit microprocessor systems
- ASIC technologies
- data acquisition and conversion
- sub-micron IC technologies
- semiconductor manufacturing and QC
- test and measurement systems
- telecommunications and ISDN
- surface mount devices
- multiprocessing technologies
- and similar topics on the leading edge of electronics.

For those who can "write the book" on hot electronics topics, Academic Press will pay generous royalties and back their efforts with intensive promotion and marketing campaigns. Editorial guidance and support will be an important part of the writing process.

**If you are interested in
being an author, contact:
Harry Helms, Senior Editor
Electronics and Electrical Engineering
Academic Press
1250 Sixth Avenue, San Diego, CA 92101
or call (619) 699-6840.
CIRCLE NO 66**

Publication lists plotter media and supplies

This 52-pg, 4-color catalog deals with the vendor's selection of plotter media from bonds and vellums to polyester drafting films and custom-printed forms. It contains a new section of business graphics films designed for use with plotters and nonimpact printers. It also describes HP plotters: HP DraftPro of personal CAD systems and the DraftMaster designed for a shared-resource environment. The publication provides photographs and specifications for plotter supplies including pens, inks, and adapters. A pen/media compatibility chart as well as a plotter-pen, trouble-shooting guide are also included.

Teledyne Post, 700 E Northwest Hwy, Des Plaines, IL 60016.

Circle No 438

Newsletter to cover impact of superconductivity

SuperConductor World Report (SCWR) is a newsletter covering developments in superconductivity. It focuses on the interests of business executives, strategic planners, investment analysts, and product engineers all over the world. Therefore, rather than handle superconductivity as a scientific phenomenon, SCWR will concentrate on the technology's economic and industrial uses, as well as its social and political implications. The second issue, for example, presents articles on investments, futures, government funding, and market strategy. Annual subscription, $385.

Empire Communications Group, 23 Empire Dr, St Paul, MN 55103.

INQUIRE DIRECT

WHAT IS PORON?

PORON® products are high density cellular urethanes which exhibit superior physical and mechanical properties. They are manufactured in densities from 15-30 pounds per cubic foot and in thicknesses from .031-.500 inches.

Key PORON properties include excellent energy absorption, low compression set, hydrolytic stability, internal strength and dimensional stability, easy fabrication and aesthetics.

WHAT IS PORON USED FOR?

Applications for PORON are as unlimited as your own imagination. And that's what the six simple tests below are designed to do—to demonstrate some of the capabilities of PORON and let your own imagination dictate where it can best fit your needs.

For example, PORON is already being used for athletic padding, vibration mounts, bumper pads, tote box liners, camera case liners, gaskets, seals, spacers, noise absorption pads and mounting tape substrates.

PROVE PORON'S WORTH TO YOURSELF.

Folder introduces absorption material

This introductory packet includes a folder and a sample of Poron products, the vendor's high-density cellular urethanes. It describes five simple tests that you can conduct right at your desk. The tests demonstrate energy absorption, resistance to impression, self-healing after puncture, resiliency, and resistance to long-term compression set.

Rogers Corp, 1 Technology Dr, Rogers, CT 06263.

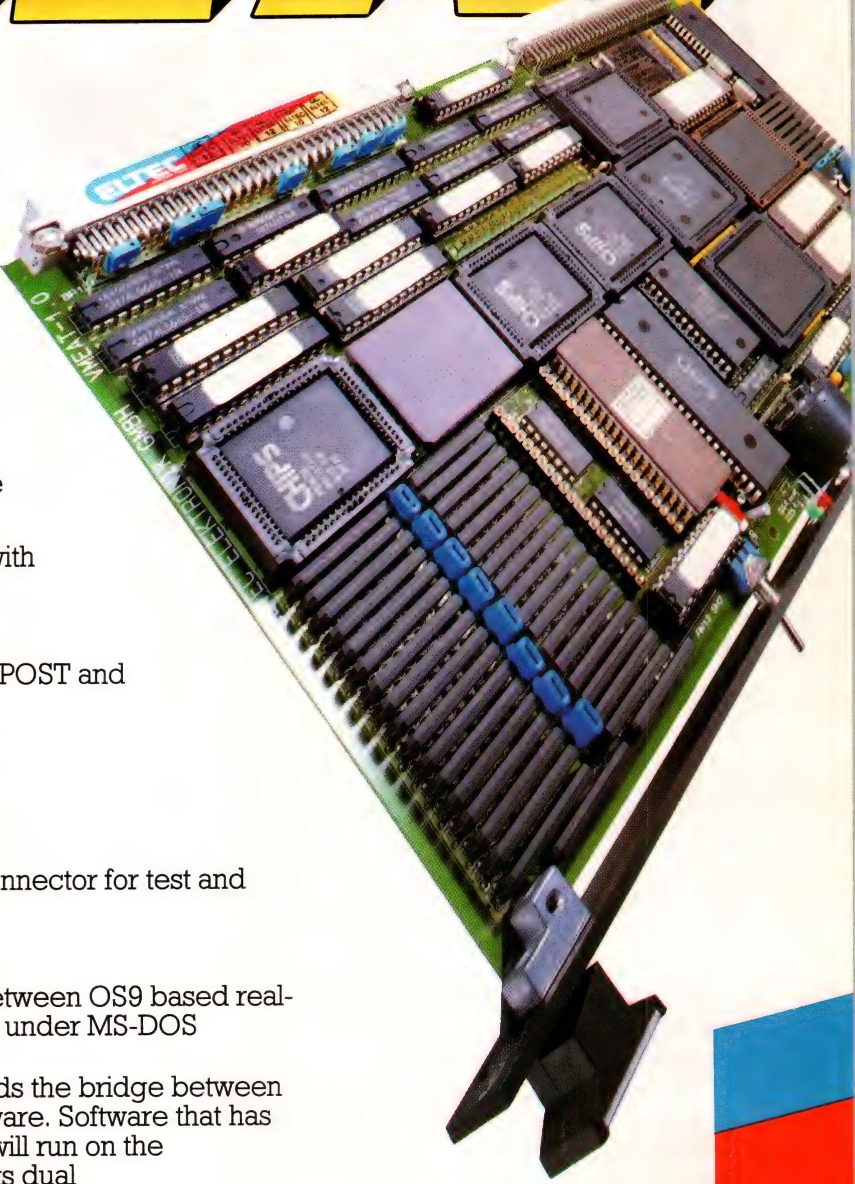
Circle No 440

Two ways to design antenna systems

The 6-pg technical bulletin *Celwave Opens the Door to 900 MHz Trunking* explains two practicable methods of designing and equipping 10-channel, 900-MHz antenna systems. These methods include the

THE BEST OF BOTH WORLDS

VME·AT



ELTEC's new VMEbus module VME-AT closes the gap that IBM left open in industrial control.

- Fully IBM AT-03 compatible VMEbus CPU module
- On-board IBM-EGA grafics interface 640 x 400 x 16 colors
- Fully VMEbus Master Slave Interface (D16 : A24)
- 1 MByte of DUAL PORTED memory with selectable VME base adress
- Floppy disk controller
- PHOENIX AT268 Bios Firmware with POST and IBM Extended Keyboard Support
- Supports all "Enhanced BIOS Calls"
- On-board EGA Bios
- Interfaces for Keyboard and COM1:
- IBM PC bus available on separate connector for test and debugging
- Runs MS-DOS, PC-DOS and OS/2
- Multiprocessor software available between OS9 based realtime CPU's and the VME-AT running under MS-DOS

Eltec's new VME-AT CPU module builds the bridge between PC Software and Industrial VME hardware. Software that has been written under MS-DOS or OS/2 will run on the VME-AT without modification. Due to its dual ported RAM and special semaphore registers, the VME-AT is particular well suited for multiprocessor applications.

ELTEC

Germany
Eltec Elektronik GmbH · Galileo-Galilei-Straße 11 · D-6500 Mainz 42
P. O. Box 42 17 38 · Tel. 0 61 31 / 50 63-0 <5 88-0>
Telex 176 131 955 · Teletex 6 131 955 = Eltec · Fax 0 61 31 / 50 63 44

USA
American Eltec, Inc. · 569 South Marengo Avenue
Pasadena, California 91101 · Phone (8 18) 4 49 - 15 58
Fax (8 18) 5 78 - 00 54

France
Eltec International SARL
1, Allée des Garays F-91120 Palaiseau
Tel. (1) 64 47 18 77 Fax (1) 64 47 09 33

PC-DOS and IBM are registered trademarks of International Business Machines · MS-DOS and OS/2 are registered trademarks of Microsoft

CIRCLE NO 239

IEEE-488 CONTROLLER FOR PS/2

MODELS 50, 60, 80

- GPIB Compatibility
- Control Up to 14 Devices
- Selectable Addressing
- Software Included

1-800-553-1170

QUA TECH INCORPORATED

478 E. Exchange St., Akron, OH 44304
TEL: (216) 434-3154 FAX: (216) 434-1409
TLX: 5101012726

CIRCLE NO 785

TIGER POWER

40-350W range of switching power supplies

Model: BM-2150
(Mini Tiger)

Lead Year's main SPSs products are:

- PS/2 models — 386 tower models
- 286/386-type PC/AT models
- Mini Tiger' super compacts
- Cubic Baby AT models
- PC/XT models — OEM are welcome

E-97155 U.S.A. LR 65589 CANADA R60200 W.G. SEMKO SWEDEN FMC8HM U.S.A. FTZ W.G.

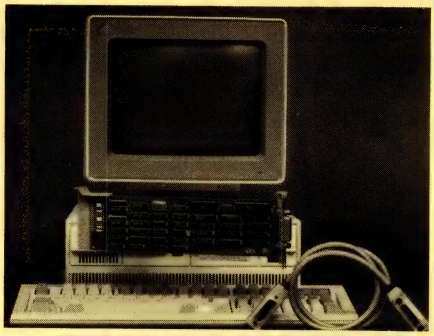
Contact us today for more information on how Lead Year's Tiger Power make your electronics great!

TIGER POWER

Lead Year Enterprise Co., Ltd.
3F, No. 481, Chung Hsiao E., Rd., Sec. 6,
Taipei, Taiwan, R.O.C.
P.O. BOX 53-352 Taipei Tel: 886-2-7857858
Tlx: 10862 LEADYEAR Fax: 886-2-7857852

PC/XT, PC/AT, Baby AT and PS/2 are trademarks of the international business Machines Corp

CIRCLE NO 786



IEEE-488 (GP-IB, HP-IB) FOR THE IBM PERSONAL SYSTEM/2™

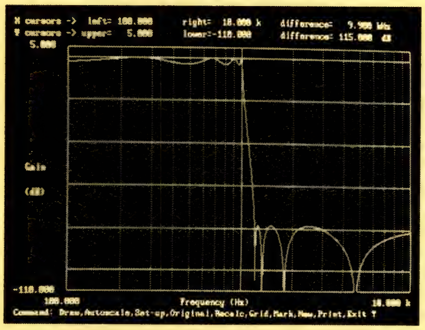
- Control instruments, plotters, and printers.
- Supports BASIC, C, FORTRAN and Pascal.
- High speed DMA and shared interrupts.
- Software library. Risk free guarantee.

cec

Capital Equipment Corp.
99 South Bedford St.
Burlington, MA. 01803

Call today (617) 273-1818

CIRCLE NO 787



X cursors -> left= 100.000 right= 10.000 k difference= 9.900 kHz
Y cursors -> upper= 5.000 lower=-110.000 difference= 115.000 dB
5.000
Gain
(dB)
-110.000
100.000
Frequency (Hz)
10.000 k
Command: Draw,Autoscale,Set-up,Original,Recalc,Grid,Mark,New,Print,Exit ?

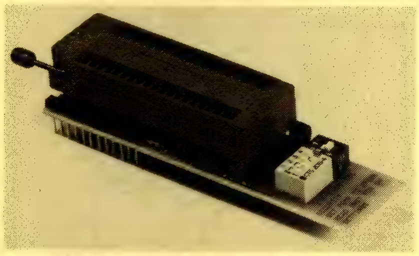
NEW! ADVANCED ACTIVE FILTER DESIGN SOFTWARE

Version 3.0 designs Lowpass, Highpass, Bandpass, Bandstop and ALLPASS filters with Butterworth, Chebyshev, elliptic and Bessel response ■ NOW calculates values for National MF-10, Reticon, MFB, VCVS, biquad and state variable filter circuits ■ Interactive graphics for group or phase delay, gain, phase, impulse and step response of the complete filter or individual section ■ Combine filters for system design/analysis ■ Modify circuits to observe effects ($525) ■ for IBM PC, XT, AT, PS/2

SPICE FILE CONVERSION OPTION AVAILABLE

RLM Research
P.O. Box 3630
Boulder, CO 80307-3630 (303) 499-7566

CIRCLE NO 788



$ 125 87C51 PROGRAMMER

The UPA87C51 converts general purpose programmers into 8751/C751 programmers. Select 2732A on your programmer, plug in the UPA, and you have an 8751/87C51 programmer. With the UPA87C51 you can also program the 8751 and 87C51 security bits and the 87C51 encryption array. It's very simple and VERY cost effective.

Price $125 including UPS ground shipping. Adapters are also available for the 63701V0, 63705V0, and 8751 and are priced at $65-$95.

LOGICAL SYSTEMS
6184 Teall Station, Syracuse NY 13217 USA
(315) 478-0722 Telex: 6715617 LOGS

CIRCLE NO 789

A Lot For A Little

Reach 137,000
specifiers of electronics
components, equipment,
and systems for
only $780.

◆

EDN Product Mart

CIRCLE NO 790

UNIVERSAL E(E)PROM PROGRAMMER $495 (Kits from $165)

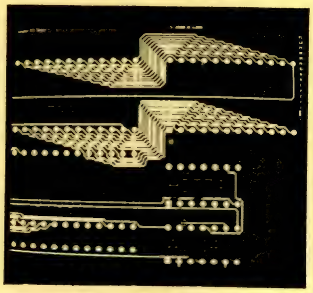
- **No personality modules;** Menu driven device selection.
- Built-in Eraser/Timer option ($50); Conductive foam pad.
- Direct technical support; **Full 1 year warranty.**
- Stand alone duplication & verify (27XX parts).
- **Quick pulse algorithm** (27256 under 60 sec).
- 27xx to 1 Mbit; 25xx; 68xx; CMOS; **EEPROMS.**
- 8741,-2,-4,-8,-8H,-9,-9H,-51,-C51,-52,-55, 9761 & more.
- **IBM-PC, Apple, CPM or Unix driver; Autobaud RS232.**
- Offset/split Hex, Binary, Intel & Motorola 8,16,32 bit.
- **Manual with complete schematics.**

VISA MC AMEX *Call today for datasheets !!*

B&C MICROSYSTEMS

355 WEST OLIVE AVE. SUNNYVALE, CA 94086
PH: (408) 730-5511 FAX: (408) 730-5521 TELEX: 984185

CIRCLE NO 791

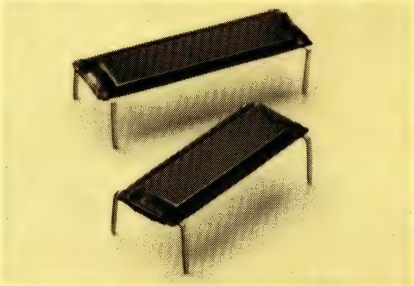


TOMORROW'S PCB CAD TECHNOLOGY...TODAY!

AutoPCB is a professional quality, PC/AT-based PCB design system integrated with AutoCAD. It features schematic capture, interactive part placement and route editing, and a powerful autorouter that uses artificial intelligence techniques to identify optimal routing patterns, as shown above, as part of the routing process. All layers of multilayer boards are routed simultaneously. Post processors for photoplotters and drill tapes are available. A large, 4500 component part library lets you start designing boards immediately. Complete PCB design systems are priced from $1995 to $4295.

PRO. LIB, INC., 624 E. Evelyn Ave., Sunnyvale, CA 94086
Tel. (408) 732-1832 FAX 408-732-4932

CIRCLE NO 792



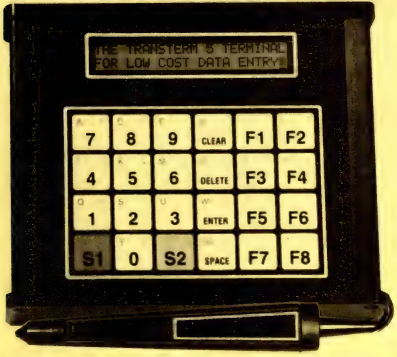
IMPROVE BOARD PERFORMANCE

MICRO/Q capacitors can be retrofitted to solve noise problems on existing boards. Because MICRO/Q caps share mounting holes with existing IC pins no board redesign is required. Effective decoupling becomes a matter of adding one insertion step. **Rogers Corp.,** 2400 S. Roosevelt St., Tempe, AZ 85282. 602/967-0624

CIRCLE NO 793

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

$249. TERMINAL



Featuring
- Standard RS-232 Serial Asynchronous ASCII Communications
- 48 Character LCD Display (2 Lines of 24 Each)
- 24 Key Membrane Keyboard with embossed graphics
- Ten key numeric array plus 8 programmable function keys
- Optional RS-422 multidrop protocol mode
- Keyboard selectable SET-UP features—baud rates, parity, etc.
- Size (5.625"W x 6.9"D x 1.75"H), Weight 1.25 lbs.
- 5 x 7 Dot Matrix font with underline cursor
- Displays 96 Character ASCII Set (upper and lower case)
- Optional Bar Code Wand (shown)

COMPUTERWISE, INC.
302 N. Winchester • Olathe, KS 66062 • 800-255-3739 • TELEX 705337

CIRCLE NO 776

Great Designs Start With Tango-Schematic.™ Just $495.

Designs quickly come to life with Tango-Schematic's easy-to-use drawing editor and extensive component libraries. Features four line types, four text sizes, repeat and block functions, unique built-in word processor. Includes DRC, BOM, Wire List, Net List outputs and crisp plots, prints, or laserprints. The perfect front end to our popular Tango-PCB and Tango-Route board design systems.

For IBM PC/XT/AT/PS2. Just $495. Full-function Demo Package: $10. Order toll-free 800 433-7801. VISA/MC. Thirty-day money back guarantee.

ACCEL Technologies, 7358 Trade St., San Diego, CA 92121
Outside N., S. America contact HST Technology (Australia)
Phone: 61-02-34-8499 FAX: 61-02-23-8771

CIRCLE NO 777

Glide Through PCB Design.

TangoPCB™ Create the toughest board designs with powerful layout software that's a snap to use. Function-rich **Tango-PCB** supports eight layers, 1 mil grid, **OrCAD**™ or **Schema**™ netlist input, print/plot/photoplot output, and more.

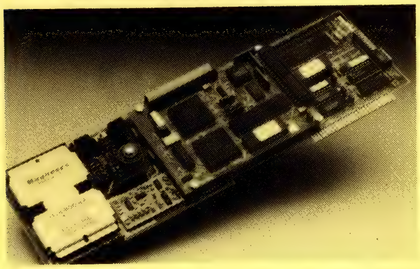
TangoRoute™ Get impressive completion rates and remarkable speed with **Tango-Route**, a four layer, eleven pass autorouter. **Just $495 each.**

For IBM PC/XT/AT/PS2. Compare features and you'll buy **Tango**. Or try full-function Demo Package, just $10. Order toll-free: 800 433-7801. VISA/MC. Thirty-day money back guarantee.

ACCEL Technologies, 7358 Trade St., San Diego, CA 92121

CIRCLE NO 777

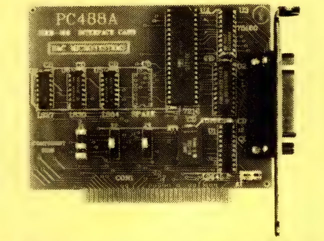
LOW COST BUBBLE MEMORY SYSTEM $713.00 FOR 720K BYTES



Rugged and reliable bubble memory systems for IBM PC/XT/AT. Master full length PC card includes SCSI host adapter and 720K Bytes of user available, non-volatile storage. Expandable to over 5M Bytes with additional slave cards. Acts like a hard disk under MS-DOS. 30ms access time. Comes complete with manual, drive and 2-year warranty.

Magnesys
1605 Wyatt Dr., Santa Clara, California 95054
Tel: (408) 988-1881 Fax: (408) 988-6165

CIRCLE NO 779



PC488 $145

LOW COST PC/XT/AT INTERFACE FOR IEEE-488 (GPIB/HPIB)

- INCLUDES INSTALLABLE DOS DEVICE DRIVERS
- 1 OF 6 INTERRUPT LEVELS
- 1 OF 2 DMA CHANNELS
- UP TO 4 BOARDS PER COMPUTER
- CONTROLLER / TALKER / LISTENER
- CUSTOM SOFTWARE SUPPORT AVAILABLE
- COMPATIBLE WITH MOST IEEE488 SOFTWARE PACKAGES FOR THE IBM PC
- QUANTITY DISCOUNTS

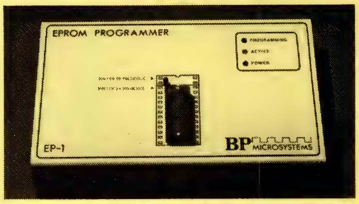
VISA MC AMEX *Call today for datasheet!!*

B&C MICROSYSTEMS

355 West Olive Ave, Sunnyvale, CA 94086
PH: (408)730-5511 FAX: (408)730-5521 TELEX: 984185

CIRCLE NO 780

EPROM PROGRAMMER $349



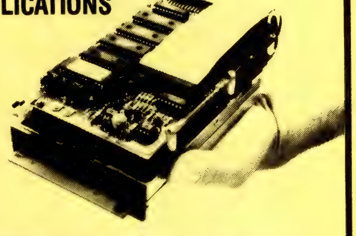
THE EP-1's A GREAT VALUE & HERE'S WHY:
- READS, PROGRAMS, COPIES OVER 300 EPROMS AND EEPROMS FROM 29 MANUFACTURERS INCLUDING 2716-27513, 2804-28256, 27011
- READS & WRITES INTEL, MOTOROLA, STRAIGHT HEX AND BINARY
- OPTIONAL HEADS PROGRAM INTEL 874X, 8751, 87C51, 8755
- MENU-DRIVEN CHIP SELECTION BY MFG & P/N; NO MODULES
- FAST, SLOW, QUICK PULSE PROGRAMMING ALGORITHMS
- SPLITS FILES BY BASE ADDRESS AND ODD/EVEN (16&32 BIT)
- ALL INTELLIGENCE IN UNIT; Z80 MICROPROCESSOR BASED
- 5, 12.5, 21, 25 VOLT PROGRAMMING FOR CMOS AND -A SUFFIX PARTS
- FREE PC-DOS SOFTWARE
- GOLD TEXTOOL ZIF SOCKET
- SAME DAY SHIPMENT
- ONE YEAR WARRANTY
- MONEY-BACK GUARANTEE
- RS232 TO ANY COMPUTER
- 8 BAUD RATES TO 38,400
- GENERATES, CHECKS CHECKSUMS
- TWO FREE FIRMWARE UPDATES
- UV ERASERS FROM $34.95

CALL TODAY FOR MORE INFORMATION

BP MICROSYSTEMS
800/225-2102 713/461-9430 TELEX 1561477
10681 HADDINGTON #190 HOUSTON, TX 77043

CIRCLE NO 781

COMPLETE DEVELOPMENT SYSTEM FOR MACHINE CONTROL APPLICATIONS



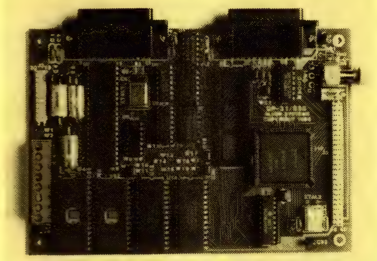
TINY188 is a low cost "PC somewhat compatible" engine for OEM controller applications. A selection of high level languages is available in ROM.

DDS188 An optional development board with EPROM programmer, floppy disk controller and added memory, removes to lower target system cost.

Prices start at $269 each/$99 at 1,000.

Vesta Technology, Inc.
(303) 422-8088

CIRCLE NO 782



80C196 BASED SINGLE BOARD COMPUTER

The CP-196 is based on the high-end 80C196 microcontroller on a chip. The board supports up to 60K bytes of EPROM/RAM, 8 channel ten-bit A/D converter, 4 eight-bit parallel ports, 3RS-232/RS-422 buffered serial ports, 3 time/counters, and is fully CMOS. We also feature boards based on the 8051, 8096, and 68HC11. Available as bare boards or assembled and tested. EPROM resident System Monitors and BASIC interpreters are also available.

ALLEN SYSTEMS
2151 Fairfax Road, Columbus, OH 43221
614-488-7122

CIRCLE NO 783

DSP ASAP $1,995

Drive your DSP design to market as fast as possible with our 320C25 in-circuit emulator.
The ICE PAK features real time emulation to 40 MHz, 16K words (35ns) program overlay memory, user definable break handler routine, single step trace, disassembler, and RS-232 communications for fast downloading of programs and data.
Options include 64K word non-volatile memory upgrade, cross assembler and communications software for PC or Macintosh.
Inquire about our 320C10 ICE PAK.

1301 Denton Drive,
Suite 204
Carrollton,
TX 75006
(214) 446-9906

MEMOCOM
DEVELOPMENT TOOLS

CIRCLE NO 784

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

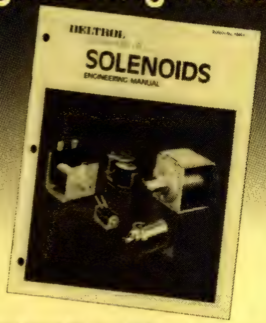
20W DC/DC CONVERTERS, 2100 SERIES BREAKTHROUGH IN SIZE/PERFORMANCE

- Dense power for great value
- 9-72VDC input range
- −25°C to +71°C ambient operation
- 2″ × 2″ × .375″ shielded case
- Short circuit current limiting
- 100% Burn-in @ FL
- 13.3W/In³ power density
- Single/dual output
- −55°C to +85°C optional extended
- No heat sink required
- Remote ON/OFF Control
- $129 (1-9) Del. 3-4 wks. ARO

CONVERSION DEVICES, INC.
101 Tosca Dr., Stoughton, MA 02072
Tel: (617) 341-3266, TLX: 920014

CIRCLE NO 767

SOLENOID Engineering Manual

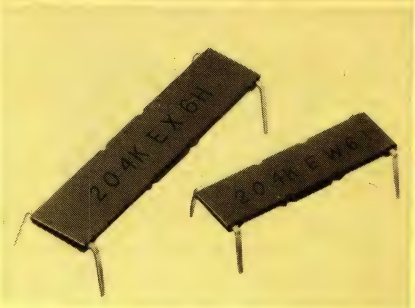


Send for the latest 68-page Solenoid Engineering Manual from Deltrol • Packed with useful information including performance data, stroke/force curves, selection factors • Industry's broadest range of miniatures, C frames, D frames, power surge, and tubular solenoids.

DELTROL controls
DIVISION OF DELTROL CORP.
4305-1

2745 S. 19th St.
Milwaukee, WI 53215
Phone 414/671-6800
Telex 2-6871

CIRCLE NO 768



MICRO/Q II

FOR A DECOUPLING CAPACITOR THAT SAVES SPACE, DEFEATS NOISE, IS SUITABLE FOR MILITARY APPLICATIONS AND BEATS HUMIDITY, HEAT AND COLD:
ROGERS MICRO/Q® II
Rogers Corp., 2400 S. Roosevelt,
Tempe, AZ 85282. 602/967-0624

CIRCLE NO 769

E & H Field Probes

$495

EDN "Readers Choice" (6/25/87)

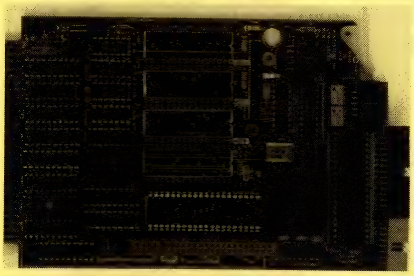
Makes finding E & H Field emissions easy!

Use with any o-scope or spectrum analyzer. Set includes three H and two E field probes, extension handle, case, documentation, two year warranty. Preamp with battery charger, optional. Call, write to order or for brochure.

1-800-253-3761
PO Box 1546 Austin, TX 78767

EMCO
The Electro-Mechanics Company

CIRCLE NO 770



16-BIT CMOS SINGLE BOARD COMPUTER
The LPM-SBC50 is an all CMOS STD Bus V-50 (CMOS 80186) SBC featuring 1M byte addressing, DMA, 32-pin memory sockets, serial RS-232/422 channel, 3 timers, 24 parallel I/O lines, real time clock, and watchdog timer. −40° to +85°C operating temperature. Very low power consumption. Available as NMOS/TTL or CMOS from

WinSystems, Inc.
P.O. Box 121361, Arlington, TX 76012
(817) 274-7553

CIRCLE NO 771

Introduce new products and literature

◆

Build awareness in the marketplace

◆

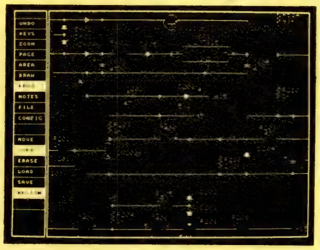
Supplement your advertising campaign

◆

EDN Product Mart

CIRCLE NO 772

SCHEMA II Schematic Capture



FREE Demo Disk: 1-800-553-9119

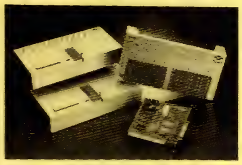
SCHEMA's success is the talk of the CAE industry and *thousands* of satisfied SCHEMA owners know why. Incredible speed, ease of use, and power have made SCHEMA a best-selling schematic capture program for engineering professionals the world over.

Now, SCHEMA II is available.
SCHEMA II sells for $495 and supports most common IBM PC/XT/AT configurations. Please call today for a *free* SCHEMA II demo disk.

OMATION
In Texas Call (214) 231-5167

CIRCLE NO 773

PROGRAMMERS
FOR IBM PC/XT/AT



- Select Device with vender name & type number directly
- Enable user to set up Program Pulse Width, Vpp, Vcc. Over-program Pulse Width & Iteration Counts.
- Capable of set & 8/16/32-bits wide-word programming.
- Built in Intellec Hex, Tektronix Hex, Motorola S, Hexadecimal, JEDEC transmission formats.
- Suspend to DOS for operation of DOS utilities.

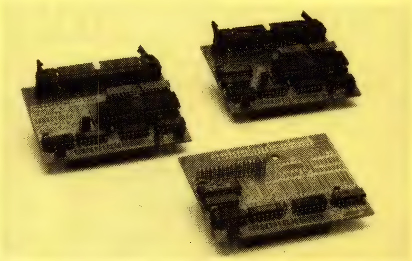
XP6000	Adapter & cable installs in PC for connecting programmer externally	$ 55
XP6001	1-socket 1M-bits EPROMs programmer	$160
XP6002	8-socket 1M-bits EPROMs programmer	$375
XP6003	1-socket MCS-48 micros programmer	$215
XP6004	1-socket MCS-51 micros programmer	$270

2 YEARS GUARANTY + 30 DAYS MONEY BACK WARRANTY

Xender Corporation
2824, KENNEDY BLVD., JERSEY CITY, NJ 07306
TEL: 201-659-2258 Tlx: 910 240 4444 CHAMPION

CIRCLE NO 774

SBX MODULES



We've upgraded our SBSxSCSI module to support Block-Mode Psuedo-DMA transfers. That means CPUs without DMA can increase transfer speeds by not polling for READY on every byte. We've also added an optional Centronics-compatible printer port (SBSxSCSI/CEN). If you only need the printer port, save money with our low-cost SBSxCEN module. We also offer a Floppy-Disk Controller module (SBSxFDC) that handles 3½″, 5¼″, and 8″ drives with SD, DD and HD formats.
Call or write for more information.

Single Board Solutions, Inc.
20045 Stevens Creek Blvd.
Cupertino, CA 95014
(408) 253-0250

CIRCLE NO 775

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

DPROM **$195.00**

RS232 Downloadable PROM (32K x 8)

- Eprom emulator for 2716's — 27512's
- Supports 8, 16, or 32 bit wide busses
- Non-Volatile memory standard
- Up to 19200 Baud
- Accepts Intel Hex formats
- 150 ns access time standard

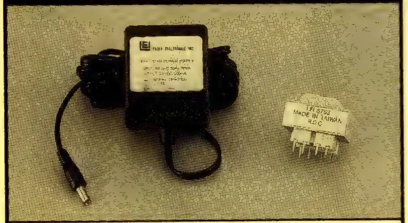
30 DAY NO RISK EVALUATION

APPLIED DATA SYSTEMS
9811 Mallard Dr. Suite 203
Laurel, MD 20708

For more information call **800-541-2003**

CIRCLE NO 758

LEADER............
A Better Tomorrow For Transformer Through Automation



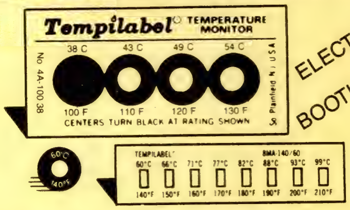
CONTACT US RIGHT NOW!

LEADER ELECTRONICS INC.

No.2, Lane 87, Pao Hsin Rd.,
Hsin Tien, Taipei, Taiwan, R.O.C.
Cable: :LEADEREL TAIPEI
Telex: 31372 LEIGROUP
Fax: 886-2-917-6809
Tel: 886-2-911-1910 (Rep)

CIRCLE NO 759

WRITE OR CALL FOR SAMPLE
Low Cost Tempilabel° Temperature Monitor.


Tempilabel° TEMPERATURE MONITOR
38 C
43 C
49 C
54 C
100 F
110 F
120 F
130 F
CENTERS TURN BLACK AT RATING SHOWN
No. 4A-100-38
So. Plainfield N.J. U.S.A.
60°C
140°F

ELECTRO BOOTH 1313

How to put a low cost temperature gauge on everything.

Label's center spot turns black when surface to which it is affixed reaches specified temperature. Single- or multi-spot labels with pre-determined increment of ratings: 100°F (33°C) to 600°F (316°C). 1% accuracy guaranteed. 1 thru 8 ratings on each monitor with various increments. Self-adhesive, removable.

TEMPIL DIVISION, Big Three Industries, Inc.
2901 Hamilton Blvd., South Plainfield, NJ 07080
Phone: (201) 757-8300 Telex: 138662

CIRCLE NO 760

---

smARTWORK® PCB Software. In a fraction of the time hand taping requires, you can create double-sided printed-circuit boards with smARTWORK and your IBM PC. The program's features include continual design-rule checking, automatic pad shaving, a silkscreen, and text for all three layers. **smARTWORK** with autorouting is $895 (without, $495) and comes with a 30-day money-back guarantee. Credit cards accepted. Write or call

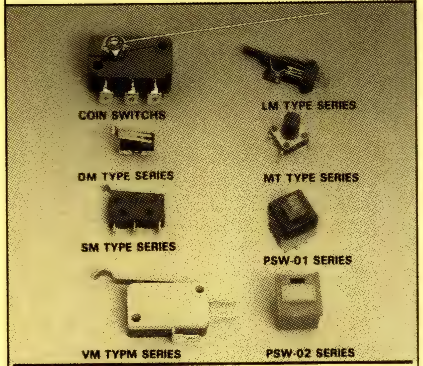
Wintek Corporation
1801 South Street, Lafayette, IN 47904
(800) 742-6809 or (317) 742-8428

CIRCLE NO 761

ZIPPY SWITCHES

NO: E91274

*FUll DETAILS AND SAMPLES ON REQUEST
*OEM ARE WELCOME



ZIPPY **SHIN JIUH CORP.**

P.O. Box 10184 SHIN TIEN TAIPEI HSIEN, TAIWAN, R.O.C.
TEL:(02) 9188512-5 TLX:33418 ZIPPY FAX: 886-2-9155765

CIRCLE NO 762

NOW – MINIATURE AT QUARTZ CRYSTALS

- 32.0 MHz – 28.0 MHz – 24.0 MHz
- 20.0 MHz – 16.0 MHz – 14.328 MHz
- 12.0 MHz – 11.0592 MHz – 10.0 MHz
- SURFACE MOUNTABLE OR WITH LEADS
- MIL TEMP RANGE AVAILABLE
- RUGGED CERAMIC PACKAGING
- CLOSE TOLERANCE & LOW DRIVE CURRENT

THE ONLY NAME YOU NEED TO REMEMBER IN QUARTZ CRYSTALS AND CRYSTAL OSCILLATORS IS STATEK!

STATEK CORPORATION
512 N. Main St., Orange, CA 92668
(714) 639-7810

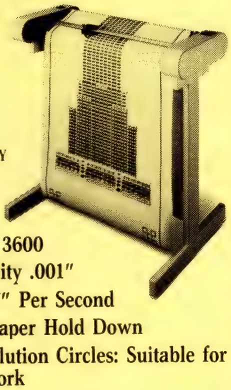
Made in the U.S.A. – Ship from stock

CIRCLE NO 763

"D" SIZE PLOTTER

$2295.00
RETAIL

$1695.00
INTRODUCTORY OFFER



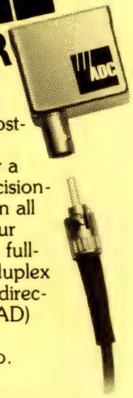
- Model PC 3600
- Repeatability .001"
- Speed at 7" Per Second
- Vacuum Paper Hold Down
- High Resolution Circles: Suitable for PCB Artwork

(415) 490-8380 **ZERICON**

STEVENSON BUSINESS PARK
BOX 1669 • FREMONT, CA 94538

CIRCLE NO 764

HALF THE FIBER



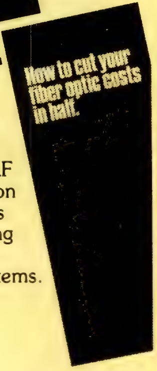
Only ADC's active couplers cost-effectively offer simultaneous bidirectional transmission over a single optical fiber. These precision-manufactured couplers contain all the optics necessary to cut your fiber costs in half. Available in full-duplex (Model CAF) or half-duplex (Model CAH). Our active unidirectional WDM (Model CAM/CAD) makes wavelength division multiplexing cost effective, too.

ADC Telecommunications®

4900 West 78th Street, Minneapolis, MN 55435
(612) 893-3010

CIRCLE NO 765

ALL THE INFO.



Learn how you can cut your fiber costs with ADC's full-duplex bidirectional CAF coupler. This free application note shows the cost savings you can achieve by installing ADC couplers in place of conventional dual-fiber systems. No cost or obligation.

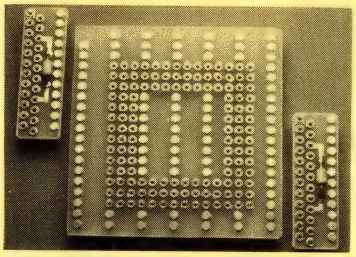
ADC Telecommunications®

4900 West 78th Street, Minneapolis, MN 55435
(612) 893-3010

CIRCLE NO 766

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

PGA & LCC PROTOTYPE



TEST ADAPTORS – VLSI

Ironwood's line of **VLSI prototype adaptors** allow prototyping of devices from 24 pin (video RAM **ZIP**), **Shrink DIP**, to **240 pin PGA, *PIP*** families **80X86 and 680X0** along with many other patterns. **Annotated test adaptors** for 68010, 68020, 80186, 80386. All gold Machined pins / most wirewrap panel patterns.
Customs – quick turnaround.

IRONWOOD ELECTRONICS, INC
P.O. BOX 21-151
ST. PAUL, MN 55121
(612) 431-7025

CIRCLE NO 349

SAILOR PROGRAMMERS: NO WAITING FOR DOWNLOAD!

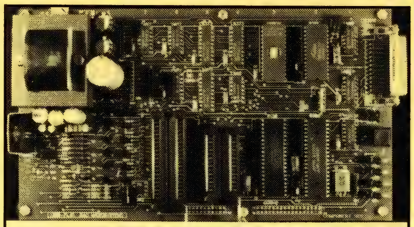
Directly controlled by IBM PC/XT/AT/PS2. Save you hours of download time each week. Virtual memory feature – requires no RAM modules even for megabit devices. Industrial quality.

Sailor-PAL: Supports PLDs from over 10 mfrs; Bipolar, CMOS, EPLD, GAL, PEEL, and ECL. S/W driven, universal electronics.

Sailor-2,-8: 2 and 8 sockets, supports EPROMs up to 1 megabit, set and gang functions.

ADVIN SYSTEMS, INC.
1050 East Duane
Sunnyvale, CA 94086
408-984-8600 TLX 5106005624

CIRCLE NO 350



UNIVERSAL E(E)PROM PROGRAMMER KITS FROM $95

- **No personality modules;** Menu-driven device selection.
- On board power supply (110/220V AC).
- Direct technical support; **Full 1 year warranty**.
- User friendly software; Complete help menu.
- **Quick pulse algorithm** (27256 under 60 sec).
- Programs 27xx to 1 Mbit; 25xx, 68xx, CMOS; **EEPROMS**.
- Micros: 8741, 8742, 8748, 8748H, 8749, 8749H & more.
- **IBM-PC, Apple, CPM or Unix driver; Autobaud RS232.**
- Offset/split Hex, Binary, Intel & Motorola 8,16,32 bit.
- Manual with **complete schematics**.

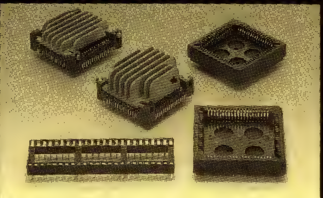
VISA MC AMEX *Call today for datasheets !!*

B&C MICROSYSTEMS

355 WEST OLIVE AVE. SUNNYVALE, CA 94086
PH: (408) 730-5511 FAX: (408) 730-5521 TELEX: 984185

CIRCLE NO 751

WINPOINT
A FULL RANGE OF CONNECTORS & SOCKET

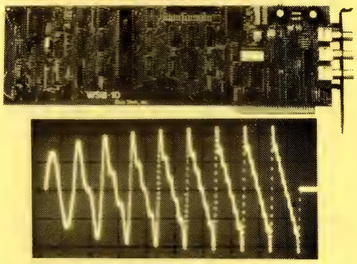


IC SOCKETS-8, 14, 16, 18, 20, 22, 24, 28, 40, 42, 48 contact
LCC SOCKET-68 contact
PLCC SOCKET-28, 32, 44, 52, 68, 84 contact series

Winpoint Electronic Corp.
P.O.Box 89-80, Taipei, Taiwan, R.O.C. Office : No. 47, Chi-Wei St., San Chung City, Taipei, Taiwan, R.O.C.
Tel: (02) 986-0208, 984-0209
Telex: 34227 WINPOINT Fax: 886-2-9838555

CIRCLE NO 752

WAVEFORM SYNTHESIZER



- For IBM-PC/XT/AT and compatibles
- Generates user-definable signal
- Up to 2000 points per envelope

QUA TECH INCORPORATED **$795.00**

478 E. Exchange St. Akron OH 44304
(216) 434-3154 TLX: 5101012726
1-800-553-1170

CIRCLE NO 753

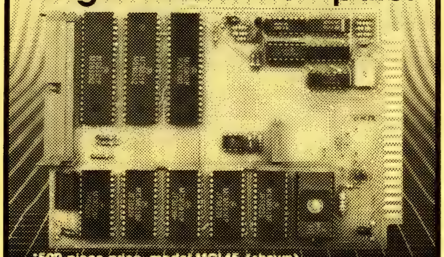
Small Space Advertising For Big Results

◆

EDN Product Mart

CIRCLE NO 754

$91.00*
Single Board Computer



*500 piece price, model MCL45 (shown)

6800 MPU, serial I/O, parallel I/O, RAM, EPROM, 44-pin 4.5″ × 6.5″ PCB
EXPANSION MODULES: RAM, EPROM, CMOS RAM/battery, analog I/O, serial I/O, parallel I/O, counter/timer, IEEE-488, EPROM programmer, floppy disks, cassette, breadboard, keyboard/display.

WINTEK
Wintek Corp.
1801 South Street
Lafayette, IN 47904
317-742-8428
(800) 742-6809

CIRCLE NO 755

FREE CATALOG
AND APPLICATIONS GUIDE

AFFORDABLE ENGINEERING SOFTWARE

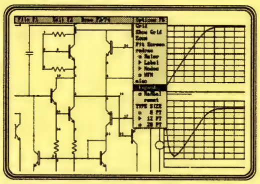
PC/MSDOS — Macintosh — CP/M

ACNAP — $125.00	AC Network Analysis, Component Libraries, Macros, AUTO Execute
DCNAP — $95.00	DC Network Analysis, Component Libraries, Macros, AUTO Execute
SPP — $125.00	Signal Processing Program Macros, AUTO Execute, Windowing
PLOTPRO — $72.95	Scientific Graph Printing
PCPLOT3 — $95.00	High Resolution Engineering Graphics Package
LOCIPRO — $95.00	Root Locus Stability Analysis, Multiple, Nested Loops
ACTFIL — $95.00	Active Filter Design, Analysis, Synthesis
MICRO-3 — $125.00	Design & Analyze Microstrip Circuits, Filters, Hybirds, Couplers, Transformers
LCFIL — $95.00	LC Filter Design/Analysis/Synthesis
LSP — $95.00	Logic Circuit Design/Simulation
RIGHTWRITER — $95.00	Report Proofreader Program. Applies 3000 Rules of English
PDP — $95.00	Scientific Plotting Program for Pen Plotters
TEKCALC — $95.00	Programmable Scientific Calculator/Statistics/Curve-fitting
COMCALC — $72.95	Communications Budget Calculator and Spreadsheet Program
XFER — $95.00	Transfer Function Analysis and Circuit Synthesis
SPANNER — $95.00	Integrated Word Processor, HP11C Calculator, and Scientific Graphics

BV Engineering
Professional Software
(714) 781-0252
2023 Chicago Ave., Suite B-13, Riverside, CA 92507 U.S.A., TELEX-3089864

CIRCLE NO 756

Analog Circuit Simulation



NEW
SPICE_NET
$295.00

Make SPICE input files from schematic drawings using pull down menus and a mouse to draw and connect parts. Use an **IBM** PC with any UC Berkeley compatible SPICE program.

Simulation Programs

- **IS_SPICE, $95.00.** Performs AC, DC and Transient analysis.
- **PRE_SPICE $200.00:** Adds Monte Carlo Analysis, Sweeps, Optimization, libraries and algebraic parameter evaluation .
- **Intu_Scope $250:** A graphics post processor works like a digital oscilloscope. Easy to use with all the waveform operations you will ever need.

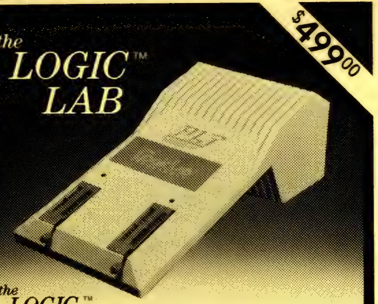
for
IBM
PC's
from
intusoft

(213) 833-0710

P.O. Box 6607
San Pedro, CA
90734-6607

CIRCLE NO 757

To advertise in Product Mart, call Joanne Dorian, 212/463-6415



the LOGIC™ LAB *is a complete logic development system*

- Complete System Including Programmer, Sample GAL Devices, Software and all Cabling.
- Programs GAL Devices Including 16V8, 16Z8, 20V8, & 39V18.
- Allows Prototyping of 42 different standard PLD's.
- Includes Updated Equation Assembler Software.
- Accepts All Standard JEDEC Download Files.
- Software Updatable.
- 30 Day Money Back Guarantee.

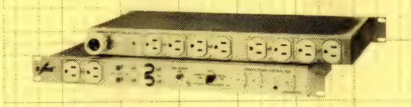
* Visa and Master Card Accepted *

CALL FOR FREE DEMO DISK

Programmable Logic Technologies, Inc.
P.O. Box 1567
Longmont, CO 80501
Ph. (303) 772-9059

GAL is a registered trademark of Lattice Semiconductor Corporation

CIRCLE NO 340



AC Power Distribution and Control System Model TPC 115-10A MTD,™ space saver design for clean power up with Multiple Time Delay™ prevents high current inrush by sequencing your computers power up. Filters AC line voltage and protects your system from voltage spikes and surges. Priced from $436 to $305.

To order call:

(714) 540-4229
FAX 714-641-9062

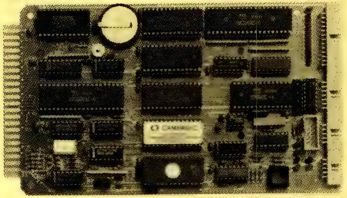
or write

Pulizzi Engineering Inc.
3260 S. Susan St.
Santa Ana, CA 92704-6865

CIRCLE NO 341

NEW

CONTROL COMPUTER



Our Multitasking Industrial Basic runs as fast as BASICA on the IBM PC/ATI. It can also handle interrupts, frequency inputs, bit manipulation, datalogging and more. The hardware includes 4 channels of Analog with 12-bit resolution, 32 digital I/O lines, battery-backed calendar clock, keypad and display ports. 2 RS-232C serial ports, 96K RAM, EPROM and EEPROM programmers, autorun mode, low power CMOS circuitry, 8 MHz Z80 CPU. Only 4.5″×8″. Stand-alone or expandable. Low cost optional software turns your IBM PC into a program development workstation. FREE CATALOG describes other models and accessories. Call **303-426-8540** for same day response.

OCTAGON SYSTEMS CORPORATION
6510 W. 91st Ave.
Westminster, CO 80030

CIRCLE NO 342

IBM COMPATIBLE RS232 EASI-DISK 3½-5¼″ FLOPPY DATA STORAGE & TRANSFER SYSTEM

Information Transfer to/from Non IBM Compatible Systems to/from IBM & Compatibles: (Over RS-232 or 488 Interface).

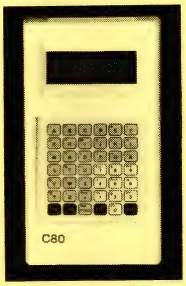
- Reads & Writes MS DOS Disks
- RS-232/488 I/O
- Rugged Portable Package/battery option
- ASCII or Full Binary Operation
- Baud Rate 110 to 38.4K Baud
- Automatic Data Verification
- Price $895 in Singles—OEM Qtys. Less.

28 other systems with storage from 100K to 35 megabytes.

ADPI
ANALOG & DIGITAL PERIPHERALS, INC.
251 South Mulberry St.
P.O. Box 499
513/339-2241
Troy, Ohio 45373
TWX 810/450-2685
FAX 513/339-0070

CIRCLE NO 343

C80 **$299**

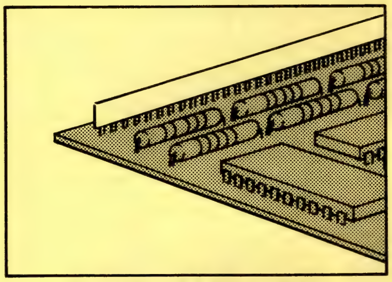


Self-Contained Computer/Terminal

- Standard Z80
- Runs CP/M SFW
- 2 × 16 T/C LCD
- Full PC Keybd
- 7″ × 4″ × 1.5″
- Bat. Clk/Cal
- Piezo Beeper
- RS-232 Port
- 2 Or 4 Wire Multidrop RS-485
- 32/64K Bytes Bat. Backed RAM
- 32K Bytes CMOS EPROM Memory
- Adaptor/Charger For 4 NiCads
- Terminal Firmware Included
- SFW Driver SRC Diskette $99
- Custom Terminals Designed

RUNIT CONTROLS, INC.
2425 N. Central Expressway Suite 241
Richardson, Texas 75080
(214) 235-2350

CIRCLE NO 344



SAVE SPACE WITH MINI/BUS® BARS

Improve power distribution
Reduce required board layers
Eliminate up to half the decoupling capacitors
Fit between or beneath IC's

Send for Rogers Mini/Bus® Bars Application Bulletin.

Rogers Corp., 2400 S. Roosevelt St.
Tempe, AZ 85282 602/967-0624

CIRCLE NO 345

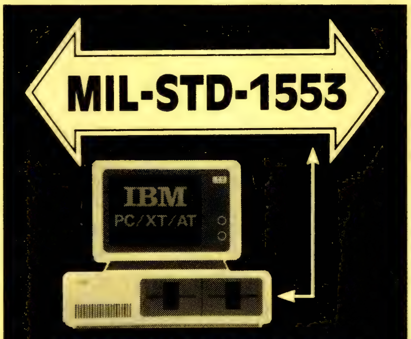
25MHz 48 CHANNEL PC-BASED LOGIC ANALYZER $1595.00

48 Channels @25MHz × 4K word deep
16 Trigger words/16 trigger sequence
Automatic set-up and loading of symbol tables
Storage and recall of trace data to disk
65K Pass/Delay Counter
16 Channel Waveform Display
12 Channels @ 100 MHz Pod Available
Affordable $1595.00 + Pod Price
Disassemblers available for:

8088	68000	8085	6801	8031
8086	Z80	6502	6303	

NCI 6438 UNIVERSITY DRIVE
HUNTSVILLE, AL 35806
(205) 837-6667

CIRCLE NO 346



MIL-STD-1553 Interface Board For IBM-PC/XT/AT or Compatibles

Dual redundant bus controller, remote terminal and monitor with powerful easy-to-use software. **From only $2095**

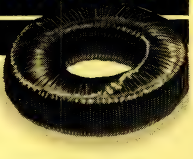
Call now for free data & demo disc

Ballard Technology
1216 N.W. 75th St.,
Seattle, WA 98117
(206) 782-8704

CIRCLE NO 347

Custom Engineered

Toroidal Transformers



Spang Supplies Solutions...Fast!

At Spang we're more than just a winding house, and our extensive experience proves it. Our engineers will detail the best overall design to meet your exact requirements. For fast solutions, call the toroidal transformer experts at Spang, or write for our free brochure.

Spang Power Control™

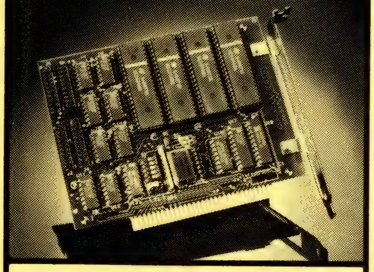
P.O. Box 457 - Sandy Lake, PA 16145
(412) 376-7515 - FAX 412-376-2249

CIRCLE NO 348

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

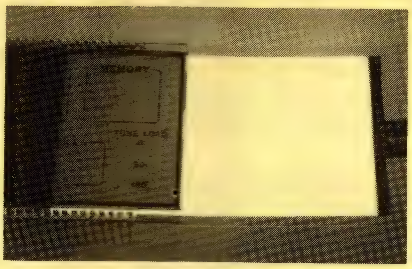
COMM + 4

- Four Serial Ports
- RS-232C Or RS-422/485
- DB-25 Or DB-9 Connectors
- Interrupt & DOS Software
- Delivery From Stock



SEALEVEL
SEALEVEL SYSTEMS INC.
PO BOX 1808
EASLEY, SC 29641
(803) 855-1581

CIRCLE NO 331



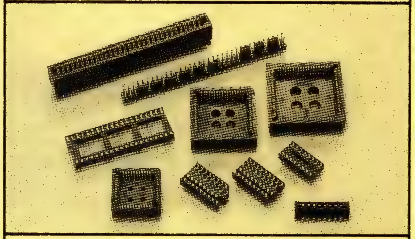
EL LCD BACKLIGHTING.

To backlight or not to backlight? With BKL's EL lamps, the answer is simple, inexpensive and fast! BKL's extremely thin (.012″ to .018″) quality lamps are made from Kard-O-Lite, a patented electroluminescent material that's easily die-cut to any size, any shape. For the fastest turnaround in the industry, at a drastically reduced cost, call Dean Smith, 215-277-2910.

BONAR KARD-O-LITE™
201 N. Presidential Boulevard
Bala Cynwyd, PA 19004
(215) 664-0633

CIRCLE NO 332

T.Z.T. SUPPLY A FULL RANGE OF CONNECTORS AND SOCKETS

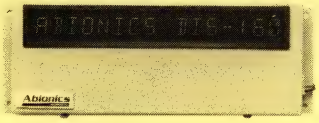


CHIP CARRIER - 44PIN, 68PIN AND 84PIN EDGE CONNECTOR - BOTH CONTACT TYPE;CANTILEVER CONTACT AND LOOP BELLOWS. LOW PROFILE IC SOCKET, MINI JUMPER, PIN HEADER AND CONNECTOR FOR FLEXIBLE PRINTED CURCUIT.

TAIWAN ZETATRONIC INDUSTRIAL CO., LTD.
No.333, Hsin Yi Road Lu Chou, Taipei Hsien
Taiwan, R.O.C. Tel: 886-2-2816395-7
Tlx: 33573 ZETACO Fax: 886-2-2832237

CIRCLE NO 333

New!



DIS-160 ALPHANUMERIC DISPLAY PANEL

- 16 - .54″ RED LED Alphanumeric displays
- Single/multi-drop RS422 interface
- Up to 32 displays on 2 wires
- Selectable baud rates to 19.2k
- Built in microprocessor provides a versatile command set including:
  - left shift, right shift
  - clear, fill
  - individual character addressing
  - 4 blink rates
  - Id answer back
- Requires only 5 volts @ 300 ma
- Size 10.5″ X 3.6″ X 1.2″

For more information about this or other products contact:

Abionics INCORPORATED
11 Prospect Street
Mt. Arlington, NJ
07856-1121
(201) 770-2603

CIRCLE NO 334

Cherry VoiceScribe™-1000 Speech Recognition System

List price only $1195

Input data and enter commands......*hands free!*
1000 word vocabulary ...... Send for information.

CHERRY
CHERRY ELECTRICAL PRODUCTS
3600 Sunset Avenue • Waukegan, IL 60087 • 312-360-3500 • FAX: 312-360-3566

CIRCLE NO 335

Join Forces

Combine your
larger ads with
EDN Product Mart ads
for a total
marketing program.

◆

EDN Product Mart

CIRCLE NO 336

8051
Z8
Super8
C
COMPILER

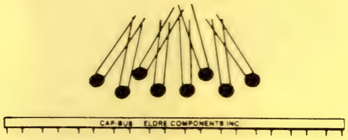
★ **Call today for a FREE technical bulletin** ★

MICRO COMPUTER CONTROL
P.O. Box 275 – Hopewell, NJ 08525 USA
Telex 9102404881 MICRO UQ

FOR IMMEDIATE ACTION CALL:
(609) 466-1751

CIRCLE NO 337

ELIMINATE DECOUPLING CAPACITORS



CAP-BUS® CAPACITOR/BUS BAR
Eliminate the decoupling capacitors and the power and ground traces from your PCB for more reliability. CAP-BUS® has a distributed capacitance of .05 micro-farads per lin. in., at 50 VDC with low inductance and low impedance. The capacitor and the bus bar have been joined together for CAP-BUS®; a more efficient capacitive decoupled power distribution system, increasing IC density on a two sided board.

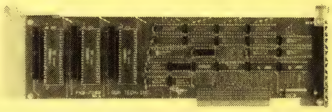
ELDRE COMPONENTS, INC.
1500 Jefferson Rd.
Rochester, NY 14623
(716) 427-7280

ELECTRO Booth #'s 465-467

CIRCLE NO 338

---

72 DIGITAL I/O
FOR PS/2



MODELS 50, 60, 80

- Parallel Expansion
- 72 I/O Lines
- Address Selectable

1-800-553-1170

QUA TECH INCORPORATED

478 E. Exchange St., Akron, OH 44304
TEL: (216) 434-3154 FAX: (216) 434-1409
TLX: 5101012726

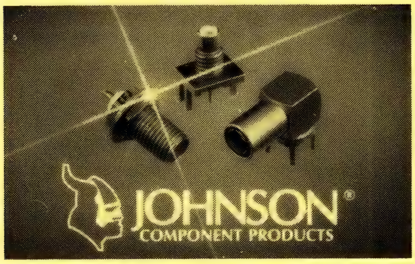
CIRCLE NO 339

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

EDN
PRODUCT MART

This advertising is for new and current products.

Please circle Reader Service number for additional information from manufacturers.



MIL QUALITY / LOW PRICE CONNECTORS

Our JCM connectors deliver the same MIL-SPEC quality as SMA-types, without charging you for expensive materials and military paperwork. The JCM line offers commercial versions of SMA/SMB/SMC RF plugs, jacks, adapters, test jacks, cable sets and PC-mount cable terminations in popular sizes and types. Get MIL-C-39012 performance without the MIL price.

Call **800/247-8343** for a free JCM catalog. (In MN: 507/835-6222)

EF JOHNSON COMPONENTS

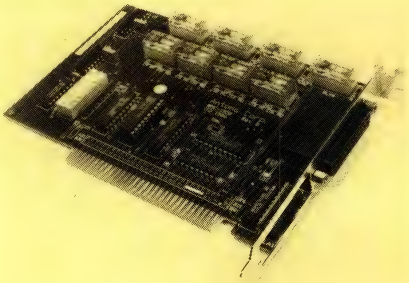
CIRCLE NO 325

Clip for READY REFERENCE

New, expanded 32-page catalog of test clips, leads, and interconnects for electronic/electrical applications. **Call (216) 771-5225.** Ask about our custom fabrication capabilities.

Mueller
ELECTRIC COMPANY
1583 E. 31st St., Cleveland, OH 44114

CIRCLE NO 326



RELAY CARD FOR THE IBM PC

The ANC-1008 provides the IBM PC with 8 discrete relays to control up to 115 VAC/1 Amp. Each relay provides a normally open/closed output, and sites for "snubber" capacitors. A 9-element LED array displays card status. Programming can be performed directly in BASIC. Unit pricing is $149.00.

Antona Corporation
1643 1/2 Westwood Blvd., L.A., CA 90024
(213) 473-8995

CIRCLE NO 327

NO ENGINEER SHOULD BE WITHOUT ONE

America's most advanced Personal Programmer

The Digital Media IQ-280 can program 40 PIN devices.

The most advanced firmware controlled pin driver system available means you never have to worry about buying another expensive module or PAK again. The IQ Personal Programmer line offers the power and features comparable to many of the $5,000 programmers, but at a fraction of the costs.

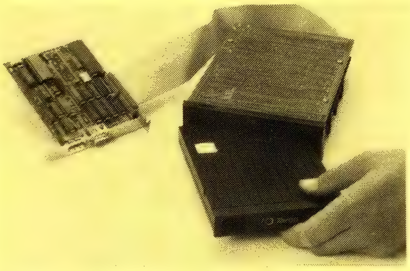
Support for CMOS, NMOS, ECL, Bipolar, PROMs, EPROMs, eEPROMs, PLDs, ePLDs, IFLs, FPLDs, up to 40 pin DIP packages.

Altera, AMD, Atmel, Cypress, Excel, Fairchild, Fujitsu, GI, Hitachi, Hughes, Intel, Lattice, Mitsubishi, Motorola, National, NEC, MMI, Samsung, Seeq, Sierra, Signetics, SMOS, TI, Toshiba, Waferscale and more. ALMOST 1000 DEVICES!

Whatever your need is, Digital Media can help you solve it. And you won't believe how little it costs.

Call (714) 751-1373 to receive a complete product specification package immediately.

CIRCLE NO 328



NON-VOLATILE CARTRIDGE RAM DRIVE

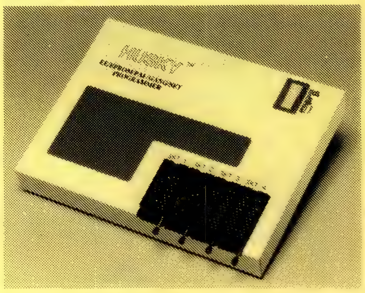
PC/XT/AT compatible mass storage. Removable 360K or 720K byte battery backed CMOS RAM cartridges. 5 year data retention. Faster than a hard disk. Rugged & reliable for industrial or mobile use. Acts like a disk drive under MS-DOS. ½ ht drive. Includes RS232 port, write protection. Controller, drive & 360K – **$695**, with 720K – **$895**.

TARGA ELECTRONICS SYSTEMS
3101 Hawthorne Rd.
Ottawa, Canada K1G 3V8
(613) 731-9941
TOLL FREE 1-800-267-9793

CIRCLE NO 329

the HUSKY™

EPROM
PLD
MICRO
GANG
SET



PC based PROGRAMMER
$599.00*

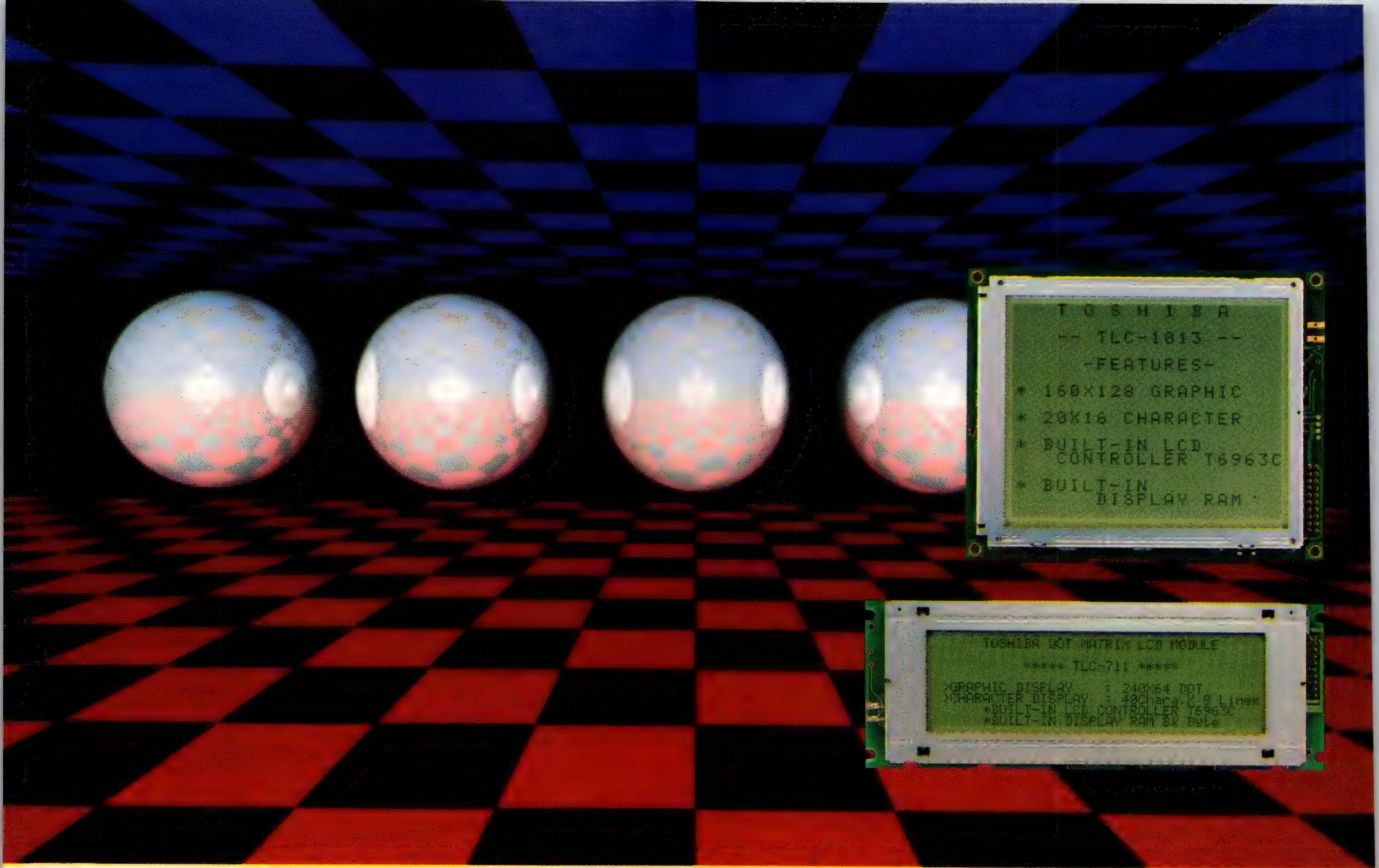
*modules not included.

From A Name You Can Trust

LOGICAL DEVICES, INC.
1201 N.W. 65th Place, Ft. Lauderdale, FL 33309
1-800-331-7766 (305) 974-0967
Telex 383142 Fax (305) 974-8531

CIRCLE NO 330

To advertise in Product Mart, call Joanne Dorian, 212/463-6415


T O S H I B A
-- TLC-1013 --
-FEATURES-
* 160X128 GRAPHIC
* 20X16 CHARACTER
* BUILT-IN LCD CONTROLLER T6963C
* BUILT-IN DISPLAY RAM
TOSHIBA DOT MATRIX LCD MODULE
***** TLC-711 *****
>GRAPHIC DISPLAY : 240X64 DOT
>CHARACTER DISPLAY : 40Chara. X 8 Lines
*BUILT-IN LCD CONTROLLER T6963C
*BUILT-IN DISPLAY RAM 8K Byte

A Wide Lineup Builds Quality and Reliability

From small to large sizes, from character to graphic displays, Toshiba has a wide lineup of LCDs with high quality and superior readability. The employment of H-TN offers you easier reading. And built-in controllers enable easy operation. There's even a module that accepts an EL backlight. So when you look for an LCD — look for Toshiba.

Character Display Type with Built-in Controller

High character height and easy-to-read display.
Easy-to-use design thanks to high contrast TN.

Model name	Number of characters	Outline dimensions (mm)
TLC-671	16 × 1	80.0 × 36.0 × 12.0
TLC-241	16 × 1	80.0 × 36.0 × 12.0
TLC-491	16 × 2	80.0 × 36.0 × 12.0
TLC-731	16 × 4	87.0 × 60.0 × 12.0
TLC-501	20 × 2	116.0 × 37.0 × 12.5
TLC-721	20 × 4	98.0 × 60.0 × 12.0
TLC-691	24 × 1	126.0 × 36.0 × 12.0
TLC-771	24 × 2	118.0 × 36.0 × 12.0
TLC-601	40 × 1	182.0 × 33.5 × 13.0
TLC-591	40 × 2	182.0 × 33.5 × 13.0
TLC-1001	40 × 4	221.0 × 76.0 × 12.5

Graphic Display Type with Built-in Controller

Clear display thanks to high contrast TN.
Easy-to-use C/G, RAM and ROM built-in types.

Model name	Number of dots	Outline dimensions (mm)	Controller
TLC-1021	120 × 64	85.0 × 70.0 × 20.0	T6963C
TLC-682	160 × 64	125.0 × 50.0 × 18.0	T6963C
TLC-711A	240 × 64	180.0 × 65.0 × 12.0	T6963C
TLC-1013	160 × 128	129.0 × 104.5 × 14.0	T6963C
TLC-1091	240 × 128	241.0 × 125.3 × 12.0	T6963C
TLC-1101	160 × 32	140.0 × 40.0 × 12.0	T6963C

*We provide many options.
*We can meet the need for customized products.

Graphic Display Type

Clear display through employment of high contrast TN.
Capable of displaying large-size letters and special letters.

Model name	Number of dots	Outline dimensions (mm)	Controller
TLC-612	640 × 32	320.0 × 48.0 × 14.0	(T6963C)
TLC-761	640 × 64	320.0 × 47.0 × 14.0	(T6963C)
TLC-341AK	128 × 128	93.2 × 86.6 × 12.0	(T6963C)
TLC-531A	128 × 128	132.2 × 111.0 × 13.0	(T7755)
TLC-972	480 × 128	274.0 × 114.4 × 20.0	(T7755)

( ): Recommended controller ICs.

In Touch with Tomorrow
TOSHIBA

VISIT US AT ELECTRO/88
BOOTH NO. 2034 – WORLD TRADE CTR.

Toshiba America, Inc., Chicago Office: 1101A Lake Cook Rd., Deerfield, IL 60015 Tel: 312-945-1500 **Northwestern Area Office:** 2021 The Alameda, Suite 220, San Jose, CA 95126 Tel: 408-244-4070 **Eastern Area Office:** 67 South Bedford Street, Suite 200W, Burlington, MA 01803 Tel: 617-272-4352, 5548

CIRCLE NO 240

If you can design it, SAFT can power it.

Now you don't have to compromise your specs. As a pioneer in lithium and NICAD® chemistries, SAFT has been a leader in the electro-chemical industry, offering power without compromise.

In fact, SAFT is the power behind this century's most innovative developments in electro-chemical energy systems. Our diverse experience includes military requirements as well as complex industrial applications, such as communications, instrumentation, metering, medical and business electronics.

So talk to the SAFT problem solvers with the broadest product range in the entire industry. Then, get the power—and the variety—to meet your design specifications precisely.

Contact Applications Engineering at SAFT America Inc., Portable Battery Division, 711 Industrial Blvd., Valdosta, GA 31601, Phone: 912-247-2331. Or contact SAFT America Inc., Lithium Battery Division, 107 Beaver Ct., Cockeysville, MD 21030, Phone: 301-771-3200.

SAFT

MORE POWER TO YOU.

CIRCLE NO 241

CGE

E-T-A® Circuit Breakers. Accepted by the world's most demanding critics.

UL, CSA, VDE. Just some of the international approvals for the full line from E-T-A—an international manufacturer of some of the finest circuit breakers in the world.

E-T-A Circuit Breakers, including commercial-grade thermal, magnetic, and combination thermal-magnetic, are trip-free and foolproof. Each undergoes 100% calibration and testing. And there's one that's just right for your application.

E-T-A's line of On-Off Switch/Circuit Breakers, with options in illumination, handle color and style, offers you further design flexibility. The single or double-pole units fit in the same panel cutout. The balance of the line includes a variety of products with non-standard current ratings, as well as shunt tap and auxiliary contact options.

The same industry-pacing standards apply to E-T-A electronic flow and level sensors, and digital display instruments.

Call today or circle the number below for your E-T-A Specifications Catalog. E-T-A Circuit Breaker quality will quickly earn your approval too.

E-T-A® CIRCUIT BREAKERS GROUP

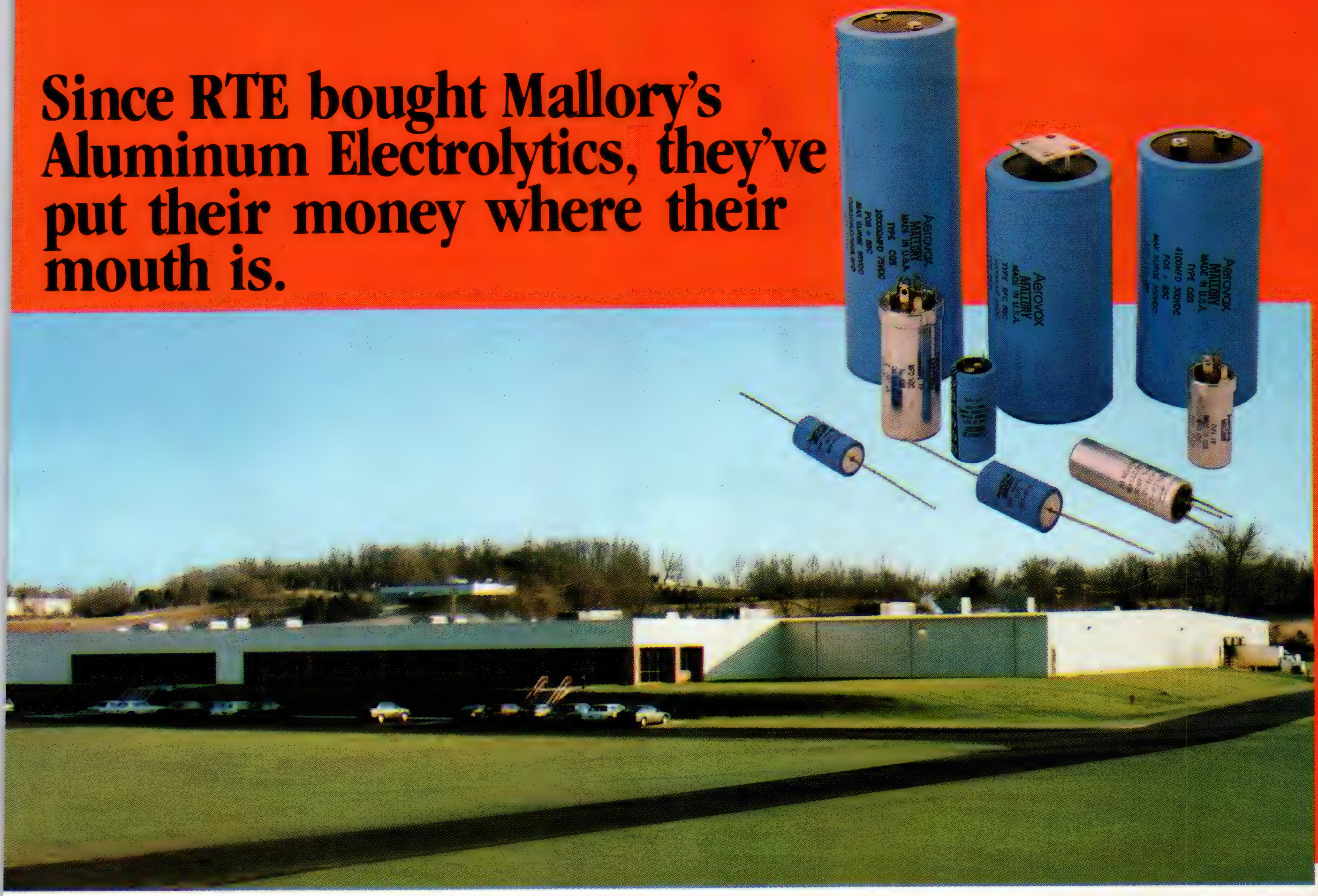
Setting the pace for circuit protection

7400 NORTH CRONAME ROAD
CHICAGO, ILLINOIS 60648
312/647-8303
FAX: 312/647-7494

CIRCLE NO 242

©1988 E-T-A CIRCUIT BREAKERS GRO

Since RTE bought Mallory's Aluminum Electrolytics, they've put their money where their mouth is.



Announcing the latest, largest investment in this dynamic product line: our new Aerovox M plant – over 50% bigger & just across the street!

When RTE bought Mallory's aluminum electrolytic capacitor line last year, priority #1 was to retain the quality and respect this fine product line already enjoyed by retaining the same facility and skilled work force. However, they immediately began building for a bigger future with new management appointments plus major improvements like key equipment upgrades, in-house CAD-assisted engineering, and a computerized order entry/customer service system. Also, field sales was assigned to the service-driven rep and distributor organization of Aerovox Inc., another RTE company and a world-leader in AC capacitors.

But for the ambitious future RTE envisioned for this vital product line, we needed more room — fast! Available land across the street from the original Mallory plant allowed us to build — then move — without losing production or a single skilled worker!

Our new plant has been shipping product for over two months, with improvements in yields and quality already evident. So now our big news is about completing another giant step on our way to becoming #1 in aluminum electrolytics. For your next cap requirement, call your Aerovox rep or us, and see for yourself what a difference a full commitment to excellence can make in a product line that was outstanding to begin with!

Send for a set of technical bulletins today.

Now we're

Aerovox MALLORY*

Glasgow, Kentucky 42141
(502) 651-8301 • FAX 502-651-9312

See us at ELECTRO, Booths 2406-08

*MALLORY is a trademark owned by and used under license from Emhart Idustries, Inc.

CIRCLE NO 243

Connectors, Sockets and Plugs to Your Requirements

Cut out to use as a Book Mark

Industrial • Military • Commercial • Prototype through Production

CRT SOCKETS
- For high resolution CRT's used in Aeronautics, CAD/CAM, Sonar, Radar, Medical and Measurement Instruments and Information Displays.
- Mate with most JEDEC and other base configurations.
- **Tube neck retaining clamp available on most sockets.**
- PC, solder tab and wire lead connections.
- With or without Spark Gaps.
- In-line resistors, chokes and capacitors.

SOCKETS
- **Tube/Relay:** 4, 5, 7, 8, 9, 10, 11, 12, 14, 16, 20, 22 and other pin configurations. PC, solder tab and chassis mount. Molded and laminated constructions. Metal or molded saddle, top or bottom mount.
- **Transistor:** TO3, 5, 9, 11, 12, 18, 33, 39, 40, 46, 52, 60, 66, 72, 104 and others.
- **Crystal:** For .486" centers (HC6/U, MIL-S-12883/4), .273", .192" (HC25) centers and others.

AUDIO & RF CONNECTORS
- Sockets, plugs and cable assemblies.
- PC, chassis or free standing mounting options.
- Vertical and right angle.
- UHF and VHF.

BATTERY CONNECTORS AND SOCKETS
- Industrial, Military and Commercial grades.
- Molded and laminated constructions.

PLUGS
- Industrial, Military and Commerical grades.
- Mate with many of our sockets.
- Molded and laminated constructions.
- Molded Boots.

OTHER INTERCONNECTING DEVICES
- Wyrlok™ molded quick connecting device.
- Molded and laminated connectors.
- Laminated receptacles.
- Fuse holders.

STANDARD, CUSTOMIZED AND NEW DESIGNS
ZERO DEFECTS QUALITY
For samples and quotes, call our engineers at 312/539-3108 or TWX 910-221-6059

Cut out to use as a Book Mark

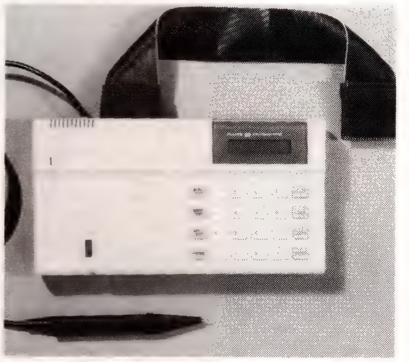
®
CONNECTOR CORPORATION
Manufacturer of Innovative, Quality American Made Connectors
6025 N. Keystone Avenue • Chicago, IL 60646-5290
Phone 312/539-3108 • TWX 910-221-6059

CIRCLE NO 64

reliability; its estimated MTBF is 500 years. The generator provides a dc-FM mode with <10 Hz/hour drift, and an amplitude-offset mode. It also has 100 storage registers for production-line use. $7900. Delivery, eight weeks ARO.

Hewlett-Packard Co, 19310 Pruneridge Ave, Cupertino, CA 95014. Phone local office.

Circle No 436



μP BOARD TESTER

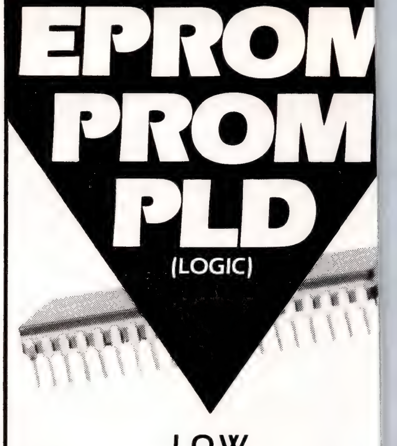
- *Clips onto boards with soldered-in μPs*
- *Tests circuits by overdriving bus and control lines*

You use the 90 Series stand-alone tester for troubleshooting pc boards that employ Z-80, 8085, and 6809 μPs. Because the tester clips onto boards under test, it can accommodate boards with soldered-in processor chips. Instead of emulating the processor, it "steals" processor cycles and overdrives the control and bus lines to test ancillary circuits, an arrangement that permits the unit under test to continue running while the tester executes diagnostic routines. Sixteen preprogrammed routines reside in the tester. The tester includes a 2-line×16-character LCD display and a 24-key keypad. You can also control it remotely via an RS-232C port. $1395.

John Fluke Mfg Co, Box C9090, Everett, WA 98206. Phone (800) 426-0361; in WA, (206) 347-6100. TLX 185102.

Circle No 437

HIGH PROGRAMMIN
YIELDS



LOW
PROGRAMMING COST

PROGRAMMERS

A complete range of low priced separate products to meet your individual specific requirement (with device manufacturers' approvals).

C41 up to 1 M bit EPROMs
E9C 8 gang EPROM & editing
E12C gang/set EPROM
1011 Bipolar PLD (logic)
1012 Bipolar PROM / EPROM
1013 set EPROM (to 32/40 pin)
1014 EPLD & CMOS PLD

Options cover single chip micros, simulators, PLCC, IBM/VAX remote drivers and ELAN LOG/iC compilers.
Ask for our DEMO DISKS.
Prices start at $995.

in Europe:
GB (0293) 510448
A (0222) 835646
B (02) 2416460
D (089) 780420
E (01) 4054213
F (014) 8632828
I (02) 6120041
I (02) 2440012
IRL (01) 501845
NL (01720) 43221
N (02) 846210
P (01) 549011
SF (00) 6926022
S (0589) 14111
S (08) 7349770
CH (01) 7414644

Elan Digital Systems
California
Tel: 800-541-ELAN
Telex: 9102400972

CIRCLE NO 65

LEADER

A TYPICAL "PORTABLE" SCOPE

THE TRULY PORTABLE
LBO-315

If both of these scopes are portable, then this is a lapdog.

What's the difference between a portable scope and the *truly* portable LBO-315? *A lot of weight*, among other things. At just 10 lbs and 10.5 x 3 x 13" with battery, the full-function LBO-315 can easily go everywhere a technician goes.

Don't waste money.

When a tech must return to the shop or a car, for the heavy scope left behind, time costs money. LBO-315, the scope techs love to carry, saves time and *delivers more profit*. It's that simple.

No so-called "portable" even comes close.

Compact 60-MHz LBO-315 packs all the performance of a bench scope. Operates from supplied 12-Vdc battery, external 10 to 20 Vdc source or 85 to 264 Vac, without switching. Has bright 3.5", 12-kV, PDA CRT; alternate trigger, time base, and sweep; 2-channel and X-Y operation; variable holdoff, and more. *All this from a unit small enough to fit into an attache case!*

Leader has "truly portable" 20 to 60-MHz oscilloscopes for ac/dc or ac operation. Each is backed by our 2-year warranty and factory service on both coasts.

Call toll-free
1 800 645-5104
In NY State
516 231-6900

Ask for our full-line Catalog, an evaluation unit, and the address of your nearest Leader Distributor.

CIRCLE NO 244

The truly portable LBO-315 comes with complete accessories, as shown at left.

Leader Instruments Corporation
380 Oser Avenue, Hauppauge, New York 11788
Regional Offices:
Chicago, Dallas, Los Angeles, Boston, Atlanta
In Canada call Omnitronix Ltd. 416 828-6221

LEADER
FOR PROFESSIONALS WHO KNOW
THE DIFFERENCE

Because you're thinking fast... count on us for the speed you need.

Now, 19ns settling op amps that survive saturations and shorts...

Comlinear's two new high-speed op amps bring you built-in protection against saturation. Plus simple short-circuit protection. That means easy solutions for fast input and output amplifiers in systems where signal level or load can't be controlled.

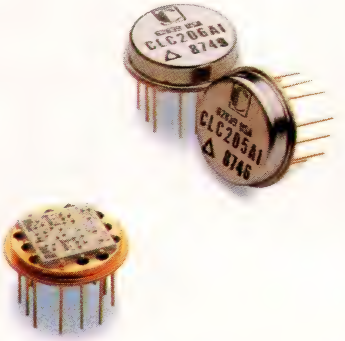
use as little as 57mW...

Our new 170MHz CLC205 offers fast dynamic performance and power consumption down to 57mW (with ±5V supplies). A settling time of 24ns to 0.05% is complemented by the drive performance of a ±12V output swing and ±50mA output current.

or drive up to ±100mA.

For higher drive, call for our 180MHz CLC206 which will drive up to ±100mA and settle in just 19ns (to 0.1%). It is coupled with a high slew rate of 3400V/μs and delivers a large-signal bandwidth of 70MHz at $20V_{pp}$.

Both of these new op amps give you saturation and short-circuit protection plus *tested and guaranteed performance at half the price of other high-speed amps.* Now you *can* be safe at high speed.

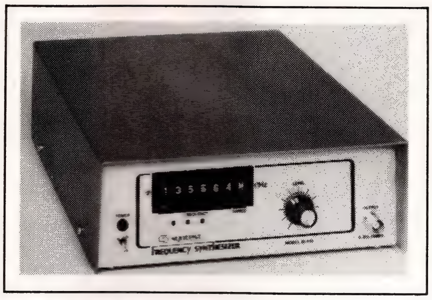


CIRCLE NO 63

Comlinear Corporation
Solutions with speed

4800 Wheaton Drive
Fort Collins, Colorado 80525
(303) 226-0500

©1988 Comlinear Corporation



SYNTHESIZER

- *Generates 0.1 Hz to 16 MHz with 5½-digit resolution*
- *Optional oscillator provides 1 ppm stability*

The Model SI-102 frequency synthesizer provides 5½ digits of resolution and covers 0.1 Hz to 16 MHz. When operating at 1 Hz and below, the unit provides a resolution of 10 μHz; when running at 1 kHz and above, it offers 100-Hz resolution. You can choose between two reference oscillators: The standard one is stable within ±10 ppm, from 0 to 50°C; the optional reference is stable to ±1 ppm. The half-rack-width instrument consumes 8W from a 50- or 60-Hz, 115 or 230V ac line. The vendor also offers BCD-programmability as an option. $681.

Syntest Corp, 40 Locke Dr, Marlboro, MA 01752. Phone (617) 481-7827.

Circle No 433

ATE

- *Combines functional and in-circuit testing*
- *Available with either 128 or 256 functional test channels*

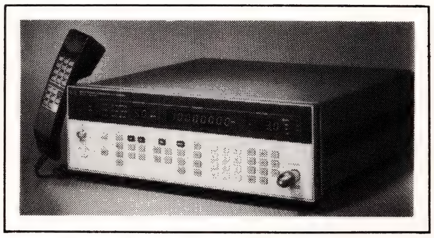
The System-730BT board-test system provides high-performance, 15-MHz functional testing, together with 10-MHz, in-circuit testing. You can dynamically switch between the two test techniques to optimize fault location strategies. Using the 15-MHz functional test channels around the edge of the board under test, you can detect device-interaction faults even on VLSI-based boards. Each functional test channel is backed by a 4k×4-bit RAM, which you can reconfigure to a 16k×1-bit RAM to handle long bit streams. All the channels are deskewed to eliminate propogation delay differences, and each channel offers 12 separate drive formats and measurement modes, including signature analysis. The system is available in either 128- or 256-channel forms and is suitable for high-speed cluster testing. It includes a timing generator in which the functional channels can apply algorithmic patterns, perform word recognition for triggering purposes, and provide both high- and low-frequency clock output functions. Around $280,000.

Schlumberger Technologies, ATE Div, Ferndown Industrial Estate, Wimborne, Dorset BH21 7PP, UK. Phone (0202) 893535. TLX 41436.

Circle No 434

Schlumberger Technologies, ATE Div, 1801 Technology Drive, San Jose, CA 95110. Phone (408) 998-0123.

Circle No 435



SIGNAL GENERATOR

- *Provides phase noise of −130 dBc at 500 MHz*
- *Shows actual power-level at DUT despite cable losses*

The HP 8657A synthesized signal generator covers the 100-kHz-to-1.04-GHz range. When running at 500 MHz, its phase noise is −130 dBc; when operating at 1 GHz, its phase noise equals −124 dBc. The residual FM is <4 Hz. In combination, these characteristics allow you to use the unit to test selectivity of radios carrying −90-dB selectivity specs. The unit incorporates an electronic attenuator that, according to the vendor, sets new standards for

Superior Semiconductor Test Performance

Matrix Switching Solutions for your ATE

Light pen accessory provides "One-Touch" control for rapid program development.

Look to the leader in low-current performance to meet your semiconductor test needs. The new Model 707 Switching Matrix includes two sub-picoamp and two high frequency CV matrix switching paths. Four additional triaxial inputs provide signal paths with performance to 20pA. Mix general purpose and coaxial matrix cards to switch an entire spectrum of signals from 5µV to 200V, DC to 30MHz, in configurations up to 2880 relay crosspoints (8x360).

Integrate the Model 707 into your system quickly and easily, with preassembled cables and standard connecting hardware. General purpose, semiconductor, and coaxial switching cards are automatically interconnected through the analog backplanes, and are easily removed for maintenance.

Relay status is continually displayed on the 707's front panel. And the interactive Programming Light Pen accessory reduces program development time by eliminating keystrokes. Store up to 100 configurations in the 707's built-in, non-volatile memory for instant recall or fast triggered relay sequences.

Technical support literature and our Applications staff will help you select the appropriate system configuration.

To get the complete story on Keithley switching, call **1-800-552-1115.**

The Model 707 Switching Matrix

KEITHLEY

CIRCLE NO 245

The vendor will offer an interface card for IBM's PS/2 series in April 1988. The host computer runs the vendor's LogiPro support software, whose device library includes more than 1200 ICs. $2795.

Logical Devices Inc, 1321 NW 65th Pl, Fort Lauderdale, FL 33309. Phone (305) 974-0975. TLX 383142.

Circle No 430

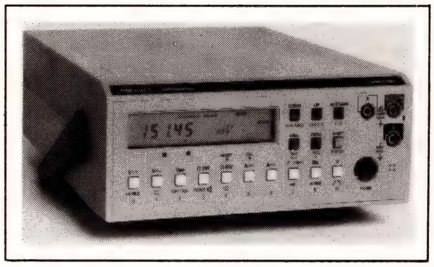
BUS ANALYZER

- *On single I/O card for IBM PC/AT, PC/XT, or compatible*
- *Captures 8000 bus states in real time*

The BusTrak microsystem-bus analyzer performs many functions usually associated with logic analyzers, code debuggers, and PC testers. It is housed on a single I/O card that plugs into an IBM PC/AT, PC/XT, or compatible computer. The unit can capture 8000 80-bit-wide data frames in real time. You can set breakpoint conditions such as reads, writes, DMA requests, CPU bus cycles, DMA bus cycles, address or data ranges, or data-bus, I/O, or memory accesses. You attach the unit by plugging it in; there are no probes or clips. Its software can automatically scan acquired data and search for conditions that you define. $1495; demonstration diskette, free.

Applied Physics Inc, 1291-E Cumberland Ave, W Lafayette, IN 47906. Phone (317) 497-1718.

Circle No 431



DMM

- *Performs 18 types of measurements*
- *Permits 4½- or 5½-digit resolution*

The PM2525 digital multimeter makes 18 kinds of measurements. It measures ac and dc voltage, ac and dc current, two- and four-wire resistance, capacitance, frequency, time, temperature, and decible level; it also checks continuity. The meter allows you to select a readout resolution of 4½ or 5½ digits; it provides five voltage, seven current, and eight resistance ranges. Its maximum resolution is 1 μV, 100 pA, 10 mΩ, and 1 pF, and its ac measurement bandwidth extends to 100 kHz. $795.

John Fluke Mfg Co, Box C9090, Everett, WA 98206. Phone (800) 426-0361; in WA, (206) 347-6100. TLX 185102.

Circle No 432

Before you waste $40,000.00 on a test system, READ THIS AD.

You've already paid for more than one half of a high-quality, low-cost test system and don't even know it. That's right, with your existing Logic Analyzer and the completely new Pulse Instruments PI-6500 Pattern Generator you can perform most of the functions of an expensive test system at a fraction of its cost.

In fact, the new Pulse PI-6500 and your Logic Analyzer can create almost any interactive Trigger/Flag/Clock/Pattern imaginable. What's more, the PI-6500 and your Logic Analyzer can both receive and input data from the DUT—making the system totally interactive.

And the PI-6500 delivers features like: 25 MHz Clock Rates, 16 to 112 Channels, 256 Trigger/Flag Combinations, Easy Programming and Serial/Parallel Modes. But don't believe just this ad, call Pulse today at (213) 515-5330 for more information.

Pulse Instruments

1234 Francisco Street • Torrance, California 90502 • (213) 515-5330

CIRCLE NO 62

mode, and you can store setup information either in nonvolatile RAM or on tape. The analyzer has an integral printer. Around $15,000.

Wandel & Goltermann, Postfach 1262, 7412 Eningen u A, West Germany. Phone (07121) 860. TLX 729833.

Circle No 426

Wandel & Goltermann Inc, 1030 Swabia Ct, Research Triangle Park, NC 27709. Phone (919) 941-5730. TLX 810-621-0002.

Circle No 427

LOGIC ANALYZER

- *Analyzes software performance at 50-MHz in real time*
- *Excludes irrelevant data from analysis*

The DT3750XA can study the performance of your software in real time at 50 MHz with no limits on the duration of the examination. The unit—which you can obtain with as many as 256 channels, configured in 16-channel increments—has logic-analysis capabilities that let you qualify the data it will consider and exclude irrelevant information. To avoid loss of data, a pair of 4k-word buffers store the acquired intelligence. While one buffer is filling, the other transmits its contents to a host computer via a high-speed interface. The state-machine triggering has 16 levels, with four test conditions per level. $13,000 to $90,000.

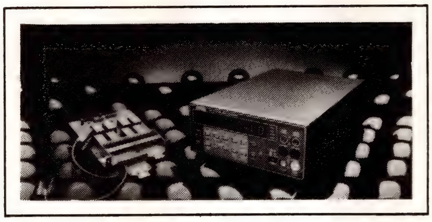
HiLevel Technology Inc, 31 Technology Dr, Irvine, CA 92718. Phone (714) 727-2100. TLX 655316.

Circle No 428

DMM

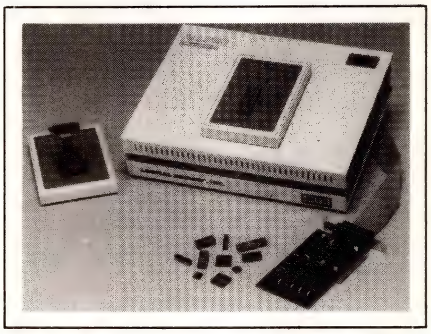
- *Performs six measurement types and resolves 5½ digits*
- *Incorporates 8-channel scanner*

The half-rack-width Model 199 DMM incorporates an 8-channel scanner and measures dc and ac voltage, dc and ac current, resistance, and dB, with 5½-digit precision. The instrument is also available optionally without the scanner; if you purchase a unit without the scanner and later decide to obtain the scanner, you can add it yourself. The unit offers sensitivity of 1 μV, 1 mΩ, and 100 nA. It can take 150 readings/sec with 4½-digit resolution and, for one year after calibration, can measure dc voltages within an error rating of ±(0.007% of reading +2 counts). The scanner performs 40 measurements/sec, offers 2- or 4-pole switching, and introduces <1 μV of thermal offset. $995 to $1395.



Keithley Instruments Inc, 28775 Aurora Rd, Cleveland, OH 44139. Phone (216) 248-0400. TLX 985469.

Circle No 429



DEVICE PROGRAMMER

- *Programs PLDs, μPs, PROMs, and sequencers*
- *Software libraries support more than 1200 devices*

The AllPro/28 programmer handles 28-pin PLDs, EPLDs, μPs, EPROMs, EEPROMs, and programmable sequencers. You can upgrade the unit to handle 40-pin devices by adding pin-driver cards. This retrofit converts the unit into the vendor's AllPro/40. You need an IBM PC, PC/AT, or compatible computer to host the programmer.

MODUTEC'S
BIG-LITTLE™
GETS BOLDER
& BRITER

THE WORLD'S ONLY LCD DPM WITH SUPER-BRITE LED BACKLIGHTING.

A cost-saving breakthrough! By using LED's...with 100K hours of life...for backlighting, Modutec's new LCD Big-Little DPM's now provide high visibility in daylight, nightlight, any light. You have a choice of red or green economical backlighting plus plug-in compatibility with Modutec standard LCD Big-Little DPM's. Backlighting power is 5, 12, 24 VDC or 115 VAC. Displays are −20°C to +65°C operating and storage with 3½ digits, ½" high, full scale of 1999. Actual size: 2.36" L. x .95" H. x .51" D. Enjoy the benefits of low power consumption with Modutec's LCD DPM featuring an LED look.

Additional features:
✱ ±200 mV or ±2V input ✱ 3 power options: 9V battery, ±5VDC or +5VDC
✱ Window or bezel mount
✱ Accuracy: ±(0.1% + 1 count)

For a day/night demonstration, contact your local Modutec sales representative, distributor or MOD Center, nationwide.

MODUTEC
THORN EMI
BORN IN AMERICA

MODUTEC, INCORPORATED
P.O. BOX 778. 18 MARSHALL ST.,
NORWALK, CT 06856–203/853-3636;
1-800/METERS-1 TWX 710-468-2039

See us at Booth #1707 ELECTRO '88

CIRCLE NO 61

MODUTEC'S

BIG-LITTLE™
GETS BOLDER
& BRITER

THE WORLD'S ONLY LCD DPM WITH SUPER-BRITE LED BACKLIGHTING.

A cost-saving breakthrough! By using LED's...with 100K hours of life...for backlighting, Modutec's new LCD Big-Little DPM's now provide high visibility in daylight, nightlight, any light. You have a choice of red or green economical backlighting plus plug-in compatibility with Modutec standard LCD Big-Little DPM's. Backlighting power is 5, 12, 24 VDC or 115 VAC. Displays are −20°C to +65°C operating and storage with 3½ digits, ½" high, full scale of 1999. Actual size: 2.36" L. x .95" H. x .51" D. Enjoy the benefits of low power consumption with Modutec's LCD DPM featuring an LED look.

Additional features:
✱ ±200 mV or ±2V input ✱ 3 power options: 9V battery, ±5VDC or +5VDC
✱ Window or bezel mount
✱ Accuracy: ±(0.1% + 1 count)

For a day/night demonstration, contact your local Modutec sales representative, distributor or MOD Center, nationwide.
See us at Booth #1707 ELECTRO '88

MODUTEC

BORN IN
AMERICA

MODUTEC, INCORPORATED
P.O. BOX 778. 18 MARSHALL ST.,
NORWALK, CT 06856–203/853-3636;
1-800/METERS-1 TWX 710-468-2039

CIRCLE NO 60

coil's Q (quality factor). The meter measures C from 1 pf to 19.99f, leakage current from 10 nA to 19.99 mA, ESR from 0.1 to 1990Ω, D/A from 1 to 100% of impressed voltage, L from 0.1 μH to 19.99H, and resistance from 50Ω to 999 MΩ. It can also test some active devices, such as SCRs and triacs. $1895.

Sencore, 3200 Sencore Dr, Sioux Falls, SD 57107. Phone (800) 843-3338; in SD, (605) 339-0100.

Circle No 423

RTD SIMULATOR

- *Simulates 2-, 3-, and 4-wire thermometers*
- *Covers −200 to +850°C*

The handheld, battery-powered RTD-700 can measure and simulate 2-, 3-, and 4-wire resistance temperature detectors (RTDs), or resistance thermometers. The unit operates in either Celsius or Fahrenheit mode, covers the temperature range from −200 to +850°C, and offers four digits of resolution, with simulation accuracy of ±0.1% of setting and readout accuracy of ±(0.1%+0.1Ω). The unit uses an industry-accepted test-current value of 1 mA to minimize the effects of self-heating of the detector. $725.

General Resistance Co, Box 185, North Branford, CT 06471. Phone (203) 481-5721.

Circle No 424

CONTROLLER ADAPTER

- *Supports programmable bus-controller IC*
- *Works with vendor's universal programming system*

The 303A-PLX LogicPak adapter works with the vendor's 29B universal programming system to program and test PLX Technology Corp's PLX 448 high-drive-current programmable bus controller. The PLX 448 meets VME Bus, Multibus I, and Multibus II specifications, among others. Abel 3.0, the design software for the 29B, also supports the PLX 448. Abel allows you to design PLX 448-based state machines by specifying their performance in terms of high-level equations. It produces JEDEC-standard programming files. $495.

Data I/O Corp, Box 97046, Redmond, WA 98073. Phone (206) 881-6444. TLX 152167.

Circle No 425

ANALYZER

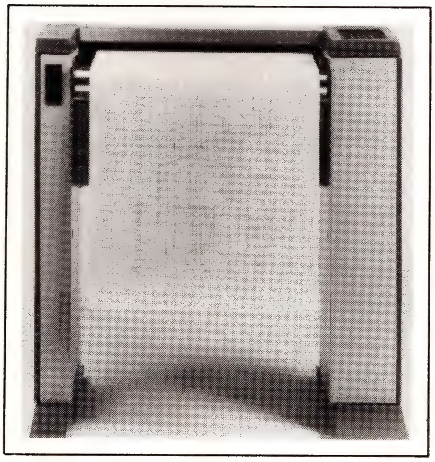
- *Monitors, emulates, and analyzes high-speed data links*
- *Suits development and testing of ISDN terminal equipment*

The DA-20 data-communications analyzer can capture and analyze data streams operating in full duplex mode at data rates as high as 72k bps. You can also use it to analyze the 192k-bps data on the S_0 interface of ISDN networks. Interchangeable EPROMs that plug into the instrument allow you to implement any data-communications protocol or procedure. The analyzer features two RX channels and one TX channel, allowing you to monitor, emulate, and statistically analyze data links. Data and programs are stored on 45M-byte tape streamer cartridges; you can thus build a library of instrument setups and results. You don't need a knowledge of high-level programming languages to program the instrument. You set it up via a simple menu-driven editor and soft-key controls. You can select transmission parameters manually or use the analyzer's autoconfigure

The control program, which runs on the PC, allows screen dumps to plotters and to dot-matrix or laser printers. $9950.

Tektronix Inc, Box 1700, Beaverton, OR 97077. Phone (800) 835-9433.

Circle No 420



PLOTTING SYSTEMS

- *Handle 24- and 36-in.-wide media*
- *Plot 200 points/in. at 1 in./sec*

Series 8500 electrostatic, monochrome printers plot 200 points/in. at 1 in/sec. The 8524 plots on 24-in.-wide media; the 8536 uses 36-in.-wide media. The units accept data in HPGL (Hewlett-Packard Graphics Language) 906/907 formats. The vendor claims that the printers are three to four times more reliable than earlier units because their parts counts are 30% lower. The units' rasterizers, which convert vectors to raster-scan data, can accept an unlimited number of vectors. A full-page buffer stores the last page printed, enabling you to rapidly obtain multiple copies of a drawing. The units can produce D-size copies at 1.67 copies/min. Their RS-232C ports accept vector data at 38,400 bps. 8524, $19,900; 8536, $24,900.

Versatec, 2710 Walsh Ave, Santa Clara, CA 95051. Phone (800) 538-6477; in CA, (800) 341-6060. TWX 910-338-0243.

Circle No 451

LCR ANALYZER

- *Measures C, leakage, ESR, and D/A of capacitors*
- *Measures L, ringing, and leakage of inductors*

The portable LC77 auto-Z meter analyzes inductors, capacitors, and resistors. It makes the following capacitor measurements: capacitance (C), leakage (shunt resistance), dielectric absorption (D/A), and equivalent series resistance (ESR). On inductors, it measures inductance (L), leakage resistance, and ringing. The meter counts the number of times that the voltage across a coil oscillates or rings following an interruption in current through the coil; the resulting total is related to the

BYTEK's 135 MULTIPROGRAMMER™ WITH 18/12 PROTECTION PLAN

Model 135-E: **$995.00***

FREE 18 MONTH WARRANTY & ALSO FREE 12 MONTH DEVICE UPDATES. BYTEK's Model 135 leads the industry with a free 18-month warranty & also free 12-month Device Updates. The 135 can program 24, 28, 32 & 40-pin (E)EPROM's from 16K to megabit devices.

THREE PROGRAMMERS IN ONE: The 135 is a SET (E)EPROM Programmer, GANG (E)EPROM Duplicator, & UNIVERSAL Device Programmer. Sets of devices, 16- & 32-bit wide, can easily be downloaded into RAM & programmed. As a stand-alone Gang Duplicator, 8 (E)EPROMS can be copied at once, (16 (E)EPROMs optional). With 2 MegaBit RAM (256K x 8) expandable to 2 MByte, the 135 supports more devices than any other production programmer. Options are available to program 40-pin EPROMs, 40-pin Micros, Bipolar PROMs, & PLD/EPLD/GAL/FPLAs.

4 OPERATING MODES: (1) Stand-alone programming, including Data Editing (2) from a host computer (3) terminal mode, and (4) menu-driven operation using BYTEK's PROMSoft IBM PC-compatible software.

COMPATIBILITY: BYTEK's 135 is Data I/O* computer remote control & terminal mode compatible. The 135 also operates under PROMlink™**. See us at Electro 88, booth #2954 or call us toll free.

BYTEK®

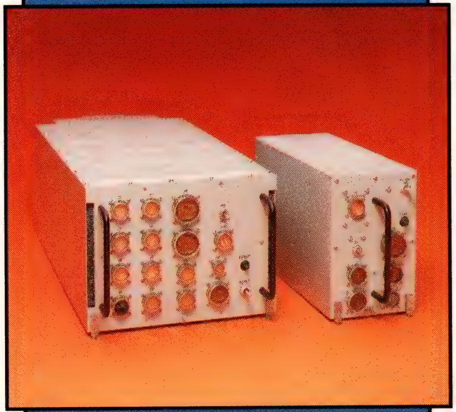
1-800-523-1565
In Florida: 1-407-994-3520

BYTEK Corporation
Instrument Systems Division, 1021 S. Rogers Cir., Boca Raton, FL 33487
Tel: (407) 994-3520 FAX: (407) 994-3615
BYTEK International
511 11th Avenue So., Minneapolis, MN 55415
Tel: (612) 375-9517 FAX: (612) 375-9460 Telex: 4998369 BYTEK

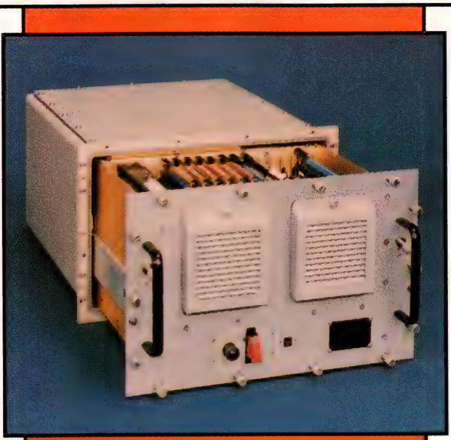
* U.S. price only. ** Data I/O & PROMlink are registered trademarks of Data I/O Corporation. (Some limitations may apply.)

CIRCLE NO 59

WHAT IS MILITARIZED, RELIABLE, OFF-THE-SHELF...?



SECS 80 FULL & ½ ATR



SECS 80/RM19

SECS 80/MCS

SECS 80 COMPUTER SYSTEMS THAT'S WHAT!

AND NOW...COMPLETE SYSTEMS

The **NEW** TITAN/SESCO now delivers complete systems, not just black boxes. We are major participants in such programs as FOG-M, North Warning, Dead-Eye and MARC to name a few. Our turn-key systems come with a range of integrated software starting from built-in-test (BIT) test firmware to complete applications software developed and validated by TITAN/SESCO.

The **NEW** TITAN/SESCO also offers standard turn-key SECS 80 based computers directed at stand-alone general purpose computing, X.25 communications, X.25 to 1553 gateway networking, and LAN applications.

MILITARY ENVIRONMENTS

Tough – All TITAN/SESCO products are designed and tested to meet MIL-E-16400, MIL-E-5400, and MIL-E-4158–and ***Radiation Hardened*** too!

Reliable – TITAN/SESCO's products stay in the field. We enjoy a return rate of less than 1% and we back all SECS 80 products with a one year warranty.

THE NDI ADVANTAGE

Building systems based on Non-Development Item (NDI) products means fast deliveries at very low development cost. TITAN/SESCO's SECS 80 Product Line is the most comprehensive line of NDI Multibus computer products in the world and is available now! Match cost to performance with SECS 80 computers ranging from 8080A based 8-bit computers to the 80286 16-bit computer and all those in between. Complete the system with the wide range of serial, parallel and analog I/O, MIL-STD-1553 and peripheral interfaces available.

CUSTOM DESIGN CENTER

TITAN/SESCO has developed a custom design center proficient in systems engineering, software engineering, electronics design, power supply design and EMI control.

THE **NEW** TITAN/SESCO Has It All . . . NDI products on-the-shelf, custom hardware and software design center and high capacity MIL-Q-9858A manufacturing facilities . . . all ready to deliver system solutions to your door!

TITAN

SEVERE ENVIRONMENT SYSTEMS

A Subsidiary of The Titan Corporation

20151 Nordhoff St., P.O. Box 2668 • Chatsworth, CA • 91313-2668 • In CA (818) 709-7100/Telex 69-1404

800-423-5527

CIRCLE NO 226

Now benchpress 400 MHz. Easy.

Arium introduces The Tool for your bench. The 400 MHz logic analyzer at a price you can handle as easily as the ML4400 handles multiple pods simultaneously . . . starting at $4995.

Arium does it again.

We just redefined high-end logic analyzers in terms of low-end cost. With the 8/16/32-bit ML4400, you can combine up to four independent-clock cards (user-selectable) to get 16 channels at 400 MHz, 64 channels at 100 MHz (synchronous), or 160 at 50 MHz (synchronous). That means you can now handle full-speed 68030s or 80386s, as well as 68020s and 8086s. And, uniquely, up to four different microprocessors, simultaneously. That's speed our competition can't catch up with. Now for ease of use.

Easy. Redefined. What does ease of use mean to you? If it means: Single key menu access to all screens. Complex triggering (Boolean, multilevel, repeat functions) with cross-triggering between state and timing, and between pods. Cross-time stamping. Transitional timing. All software resident . . . Then, you'll find them all, and more, in the ML4400.

Why Arium? How can Arium be the first to put this much low-cost power on your bench? Because we've always been first, ever since we redefined performance/price logic analyzers with our ML4100. When will the competition catch up with the performance/price of our new ML4400? Don't hold your breath.

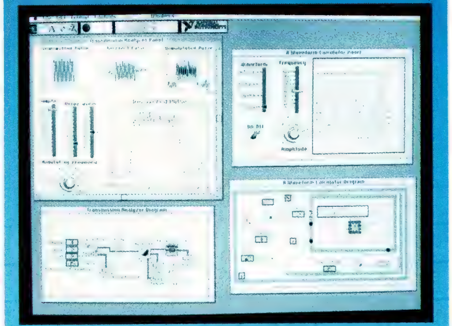
For more data on the new ML4400, as well as on our family of Arium 8/16/32-bit logic analyzers at prices as low as $2495, contact ARIUM CORPORATION, 1931 Wright Circle, Anaheim, CA 92806-6052. Telephone 800/TO-ARIUM (800/862-7486), (714/978-9531 in CA).

ARIUM CORPORATION

Arium does it again!

See us at ELECTRO, Booths 2356-2358

CIRCLE NO 76



LabVIEW

The Scientific and Engineering Software System for Data Acquisition and Instrument Control

- Data acquisition, analysis, management, and presentation
- User-designed front panels
- User-designed block diagrams for efficient software construction
- Support for IEEE-488, A/D, D/A, DI/O, DMA, and Timing
- Libraries for digital signal processing, statistics, curve fitting, data acquisition, and instrument control
- Modeling and simulation

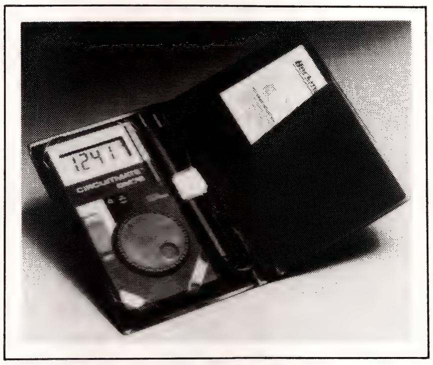
NATIONAL INSTRUMENTS™
The Leader in IEEE-488
12109 Technology Blvd.
Austin, Texas • 78727-6204

CALL FOR *FREE* CATALOG
800/531-4742•512/250-9119

CIRCLE NO 58

NEW PRODUCTS

TEST & MEASUREMENT INSTRUMENTS



MINIATURE DMM

- *Is credit-card size*
- *Costs $29.95, including test leads*

The Circuitmate DM78 credit-card-size 3½-digit autoranging DMM features readings that range from 200 mV to 400V dc, 2 to 400V ac, and 200Ω to 20 MΩ. The error in dc voltage measurements equals ±0.7% of reading. The unit includes a carrying case, manual, and test leads. It features input impedance in excess of 1000 mΩ; ac overload protection to 700V rms; and a case that withstands 2 kV ac without arcing. The unit provides a low-voltage dc range as well as low- and high-resistance ranges. $29.95.

Beckman Industrial Corp, 3883 Ruffin Rd, San Diego, CA 92123. Phone (619) 495-3240.

Circle No 421

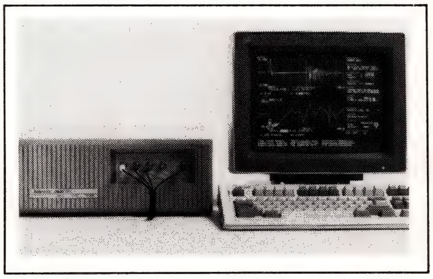
LOGIC ANALYZER

- *Captures 10M bits×64 channels*
- *Acquires 16-channel data at 200 MHz*

Without multiplexing, the K450M logic analyzer system can capture as many as 10 million, 64-bit-wide data frames at speeds as high as 50 MHz. From the front panel, you can reconfigure it to capture 40 million, 16-bit-wide data frames at speeds as high as 200 MHz. Another member of the series, the K450B, can record 80-bit-wide data frames. Each system includes an analyzer, an IBM PC/AT-compatible computer, and a multimegaword memory with either 2.5M bits or 10M bits/channel. The vendor also offers the 80386 MAP (microprocessor analysis package), an 80386 μP disassembler that also supports the 80287 and 80387 coprocessors. Analyzer, $165,000; disassembler, $2495. Delivery, 90 days and eight weeks ARO, respectively.

Gould Inc, 3631 Perkins Ave, Cleveland, OH 44114. Phone (216) 361-3315.

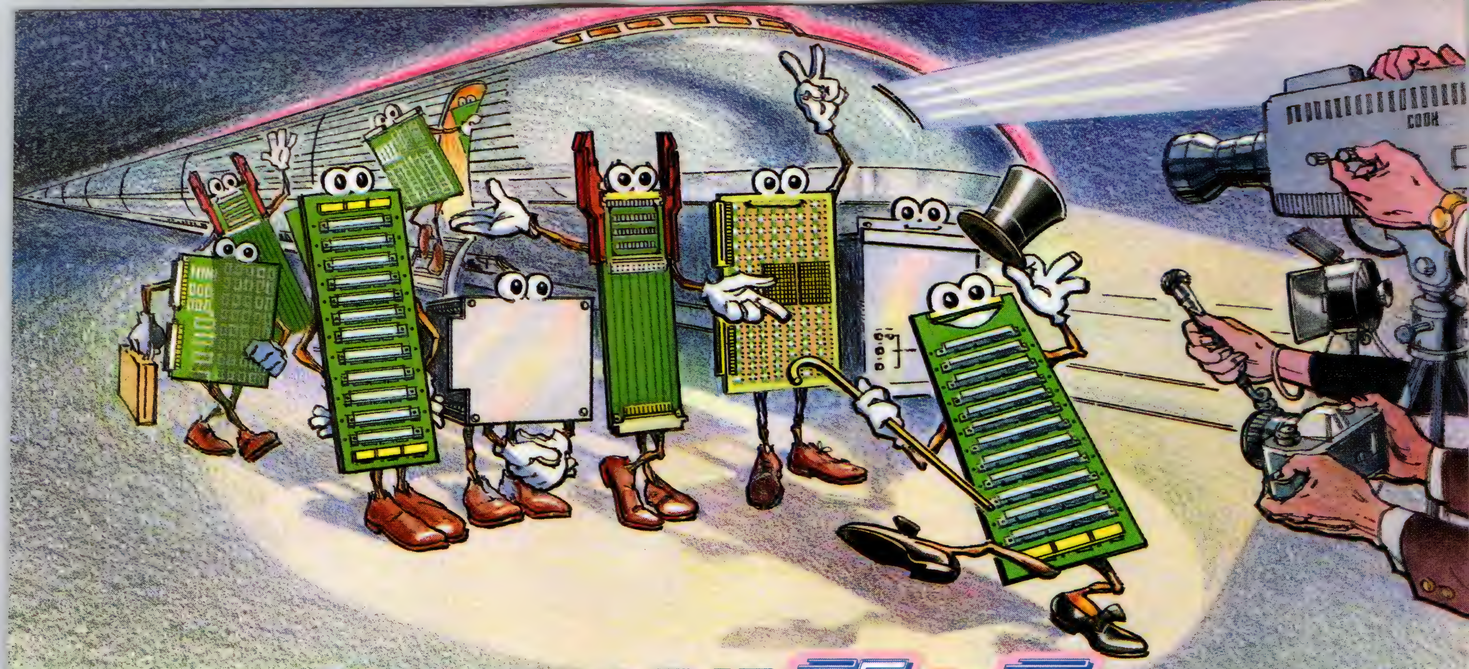
Circle No 422



FOURIER ANALYZER

- *Has two 20-kHz bandwidth channels*
- *Averages spectra in real time at 10 kHz*

The standard 23-lb 2630 Fourier analyzer comes with two channels, but you can also obtain a four-channel version. The analyzer samples all channels simultaneously and provides 20-kHz bandwidth on each channel, with 75-dB dynamic range. The unit connects to the RS-232C port of an IBM PC or compatible computer equipped with an IBM EGA or compatible card. The analyzer's capabilities include computation of transfer functions, power spectra, coherence, impulse response, and cross spectra. It performs real-time spectral averaging of data gathered at a 10-kHz rate.



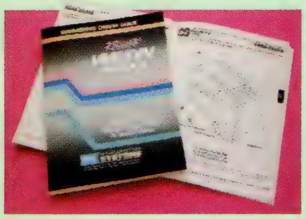
AUGAT's VME Express Delivers An All-Star Lineup!

Augat's All-Stars demonstrate real team spirit — the concept that the whole is greater than the sum of its parts. With Augat, you benefit from an integrated program that assures you a COMPLETE VME solution. Unique advantages like nationwide distribution, a comprehensive VME Engineering Design Guide and an in-depth line of quality products combine to give you value that greatly exceeds any line of "hardware only."

Delivery when you want it —wherever you are

Over 100 distributor locations . . . because one or even several stocking locations can never provide the product availability and service that 100 savvy Augat distribution sites can muster.

Augat is teamed with national distributors whose business depends on their ability to supply off-the-shelf product and value-added custom assemblies "just in time." You can count on your Augat distributor and Augat's extensive VME product line to give you what you want when you want it!

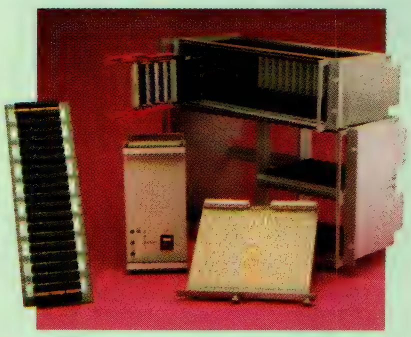


In-depth technical documentation always at your desk

Design and systems engineers require complete product documentation.

Augat's VME Engineering Design Guide has been prepared to assist you in the critical design/specification stage of projects that require system-level packaging. It focuses on the whole system from backplanes to power supplies, including a detailed electrical characterization of backplanes, and how each variation can affect your system.

So next time you're considering a VME approach, buy more than product — buy an integrated solution from Augat. Work with an All-Star Team!



Augat's VME All-Stars include:

- ☐ Backplanes
- ☐ Card Cages
- ☐ Wire-Wrap Panels
- ☐ Unilayer II Boards
- ☐ Multilayer Boards
- ☐ Extender Boards
- ☐ Power Supplies
- ☐ SMD and PGA Adapter Sockets

Request Augat's New VME Engineering Design Guide or refer to Gold Book Vol. 3/AUG.

AUGAT® INTERCONNECTION SYSTEMS

40 Perry Avenue, P.O. Box 1037, Attleboro, MA 02703
(617)222-2202 FAX (617)226-5257 TWX 671-6047

INTERNATIONAL OFFICES: Northern Europe Augat Ltd. (0908) 676655/**Central Europe** Augat Gmbh 089 576 085
Southern Europe Augat SA 1 46 68 30 90/**Japan** Augat KK 45 473-7301

Visit us at ELECTRO in Boston, May 10-12, Booths 422-31 **CIRCLE NO 75**

digelec *PROM & Logic Programmers*

THE LOW COST OF HIGH PERFORMANCE... AS LOW AS $1495.

MODEL 824
PORTABLE PROGRAMMER

- **PROGRAMS:**
  - ☐ **16K to 1024K** Bit **E²/EPROMs** from all manufacturers (more than 220 devices)
  - ☐ **Intel (87xx)** and **Motorola (68701/68705,** 28-and 40-pin) **single chip micros**
- **FEATURES:**
  - ☐ **64K Byte** standard **RAM** (expandable to **256K Byte)**
  - ☐ **Built-in UV eraser**
  - ☐ Fully **programmable VCC & VPP** for future programming needs
  - ☐ Plug-in **SOFTPACK** cassette for do-it-yourself software updates
  - ☐ **Detects Device type** (signature)
  - ☐ **Detects misplaced** device
- **SUPPORTS:**
  - ☐ 5 different programming algorithms, including **Intel Intelligent** and **Quick-Pulse, AMD Flashrite**
- **OFFERS OPTIONALLY:**
  - ☐ **SOFTLINK** remote control software for **IBM PC/XT/AT**
  - ☐ **PLCC** module
  - ☐ Adapter for **1 M bit EPROMs** and **Motorola micros**

We provide on-line technical support and have a fully staffed lab on site.

digelec

USA: DIGELEC INC.,
22736 Vanowen Street
Canoga Park, CA 91307
Tel: (800) 367-8750
In CA: Tel: (818) 887-3755
Fax: (818) 887-3693

EUROPE: DIGELEC AG,
Dorflistrasse 14,
CH-8057 Zurich, Switzerland
Tel: 01-312 46 22
Fax: 01-312 46 66,
Tlx: 823795 dige ch

CIRCLE 48

---

digelec *PROM & Logic Programmers*

1-2-3-4 AT A TIME MAKES PROGRAMMING AS EASY AS 1-2-3-4 FOR ONLY $1995.

MODEL 825
SET PROGRAMMER

- **PROGRAMS:**
  - ☐ Up to 4 devices simultaneously with the **same** or **different** data.
  - ☐ **16K to 1024K** Bit **E²/EPROMs** from all manufacturers (more than 220 devices)
  - ☐ **Intel (87 xx)** and **Motorola (68701/68705,** 28- and 40-pin) **single-chip micros**
- **FEATURES:**
  - ☐ **8, 16, 32** bit or **GANG** operations
  - ☐ **64K Byte** standard **RAM** (expandable to **256K Byte)**
  - ☐ **Built-in UV eraser**
  - ☐ Plug-in **SOFTPACK** cassette for do-it-yourself software updates
  - ☐ Programming **Verification at 3 VCCs**
  - ☐ Fully **programmable VCC & VPP** for future programming needs
  - ☐ **Detects Device type** (signature)
  - ☐ **Detects misplaced** device
- **SUPPORTS:**
  - ☐ 5 different programming algorithms, including **Intel Intelligent** and **Quick-Pulse, AMD Flashrite**
- **OFFERS OPTIONALLY:**
  - ☐ **SOFTLINK** remote control software for **IBM PC/XT/AT**
  - ☐ **PLCC** module
  - ☐ Adapter for **1 M bit EPROMs** and **Motorola micros**

digelec

USA: DIGELEC INC.,
22736 Vanowen Street
Canoga Park, CA 91307
Tel: (800) 367-8750
In CA: Tel: (818) 887-3755
Fax: (818) 887-3693

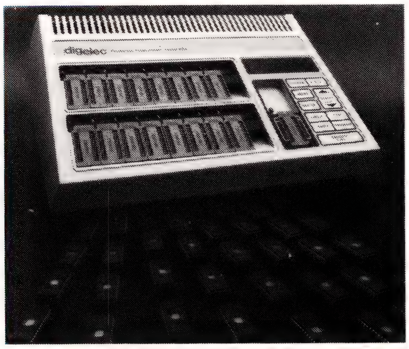
EUROPE: DIGELEC AG,
Dorflistrasse 14,
CH-8057 Zurich, Switzerland
Tel: 01-312 46 22
Fax: 01-312 46 66,
Tlx: 823795 dige ch

CIRCLE 49

---

digelec *PROM & Logic Programmers*

BUILT-IN ACCELERATOR KEEPS YOUR EPROMS ON THE RUN! FOR ONLY $2695



MODEL 828
PRODUCTION PROGRAMMER

- **PROGRAMS:**
  - ☐ **16 E²/EPROMs** at a time!
  - ☐ **16K to 1024K** Bit **E²/EPROMs**
  - ☐ **MOS, CMOS, "A"** and **OTP** EPROMs **(DIP & PLCC)**
- **FEATURES:**
  - ☐ Fully **programmable VCC & VPP** for future programming needs
  - ☐ Plug-in **SOFTPACK** cassette for do-it-yourself software updates
- **SUPPORTS:**
  - ☐ 5 different programming algorithms, including **Intel Intelligent** and **Quick-Pulse, AMD Flashrite**
- **DETECTS:**
  - ☐ **Device type** (signature)
  - ☐ **Reverse** or **misplaced** device
- **OFFERS OPTIONALLY:**
  - ☐ **RS-232C** interface
  - ☐ **64K/256K Byte RAM**
  - ☐ **PLCC** module

Programming Time
(in seconds for 16 devices)

DEVICE	*INTEL 1	*INTEL 2	AMD	FUJITSU
2764	45	40	40	30
27256	185	50	151	135
27512	385	110	325	280

*1 = Intelligent   2 = Quick-Pulse

digelec

USA: DIGELEC INC.,
22736 Vanowen Street
Canoga Park, CA 91307
Tel: (800) 367-8750
In CA: Tel: (818) 887-3755
Fax: (818) 887-3693

EUROPE: DIGELEC AG,
Dorflistrasse 14,
CH-8057 Zurich, Switzerland
Tel: 01-312 46 22
Fax: 01-312 46 66,
Tlx: 823795 dige ch

CIRCLE 50

8051 family and that can use all 8051 memory spaces. When you're writing programs for enhanced µCs such as the 8052, you can also use the upper 128 bytes of on-chip memory to store variables. The compiler lets you declare individual subroutines as static, which reduces code size and improves execution speed. According to the vendor, the code is efficient enough that you should not need to rewrite time-dependent routines in assembly language. The compiler does not support a few Pascal features, such as real-number arithmetic, but it does support the interrupt handling, special-function registers, and internal bit operations of the 8051. The compiler runs on the IBM PC and compatibles. Compiler, $495; with AVMAC macroassembler, $795.

Avocet Systems Inc, Box 490, Rockport, ME 04856. Phone (207) 236-9055.

Circle No 415

IEEE-488 SOFTWARE

- *Lets you write IEEE-488 control programs in C or Pascal*
- *Runs under the OS-9/68k operating system*

This IEEE-488 management software package allows a VME Bus computer system to control an IEEE-488 instrumentation bus. It lets you implement IEEE-488 talker, listener, and system-controller functions. The software comprises an IEEE-488 manager and an IEEE-488 device driver that run under the OS-9/68k operating system and that permit you to write application programs in C or Pascal. Running as a background task, the manager configures and initializes the IEEE-488 bus and arbitrates all communication between the IEEE-488 device driver software and the application program. To execute an IEEE-488 bus operation, the application program passes a command parameter block—specifying the device name and address, the action required, and the source and destination of transferred data—via the manager to the device driver. A device descriptor provides the driver with information about the addressed device's IEEE-488 capabilities. The manager also includes a time-out monitor to detect excessive delay in an instrument's response. The software package further includes sample device descriptors, a menu-driven system test program, and sample application programs. $750.

Compcontrol bv, Stratumsedijk 31, 5600 AD Eindhoven, The Netherlands. Phone (040) 124955. TLX 51603.

Circle No 416

Compcontrol Inc, 15466 Los Gatos Blvd, Suite 109-365, Los Gatos, CA 95032. Phone (408) 356-3817. TWX 510-601-2895.

Circle No 417

Noise problems? Soundmat LF™ is a real noise "stopper."

The secret of Soundcoat's exclusive SOUNDMAT LF is an inner limp mass flexible septum between one layer of isolation foam and an outer layer of embossed foam.

While the first layer of foam adheres to the source of noise, the flexible septum in the middle acts as a floating wall to reduce noise penetration. The outside layer of foam is embossed, making this composite capable of soaking up maximum energy with minimum thickness.

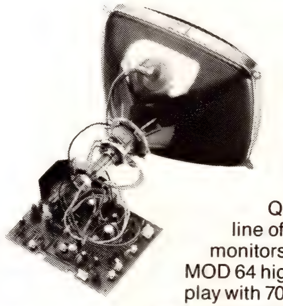
The noise stops here.

SOUNDCOAT®

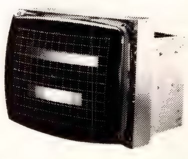
One Burt Drive, Deer Park, NY 11729 516-242-2200
3002 Croddy Way, Santa Ana, CA 92704 714-979-9202

Send for your free noise control bulletin no. 709, today.

Color & Monochrome Monitors, quality customized to the job



Wells-Gardner offers the first completely integrated family of interactive color displays. The Prismatic™ K7000 series satisfies your requirements for high quality RGB analog, graphic-over-video, NTSC, audio and much more.



Quality characterizes Wells-Gardner's line of monochrome monitors including the MOD 64 high-density display with 70kHz scanning frequencies and more than 100 dots/inch resolution and the new MOD 100- 100kHz and 120 dots/inch. The versatile Optimiser™ offers optimum performance in a space-saving package to complement your most complex custom designs.

WELLS-GARDNER ELECTRONICS CORPORATION 2701 N. Kildare, Chicago, IL 60639
312/252-8220 TELEX: 25-3286

SERVING CONSUMER AND INDUSTRIAL ELECTRONICS FOR MORE THAN HALF A CENTURY

ent programmmers are writing the subsystems. When you examine your programs, C Scan lets you use symbolic names to locate and display portions of code, regardless of the source-code file in which they're contained. By keeping a record of your program's files, C Scan lists the type of items in the program, such as functions, global variables, structures, and union members; upon your selection of an item, C Scan displays all items of that type in your program and lets you locate them. You can obtain the utilities separately or as part of the C Dev cross-development tool set, which also includes a C cross compiler, a mimic simulator, and a crossassembler. C Scan, £195; C Documenter, £195; C Dev, about £2000.

Real Time Systems Ltd, Viking House, Nelson St, Douglas, Isle of Man, UK. Phone (0624) 26021. TLX 94011289.

Circle No 413

REAL-TIME OS

- *Operates with minimal hardware configuration*
- *Provides many real-time tasks and features*

The UniFlex/RT multiuser, multitasking operating system for VME Bus systems based on the 68020 processor is now available for Apple's Macintosh II computer. The real-time features include fast message exchanges, a named enqueue/dequeue mechanism, shared data pages and text segments, and other facilities needed by real-time systems. The OS runs on a minimal Macintosh II computer that has at least 1M byte of main memory, 20M bytes of disk storage space free, and the 68851 memory-management chip. If you have a larger hard disk, you can partition the disk so that you can use the Mac OS as well as UniFlex/RT. The system comes with the utilities that you'll need for real-time, assembly-language software development, including a relocating macroassembler, a linking loader, a library generator, a symbolic debugger, and file- and system-maintenance programs. You can also obtain such options as a System V-compatible C compiler, X-Windows, a screen editor, and a text processor. $750.

Technical Systems Consultants Inc, 111 Providence Rd, Chapel Hill, NC 27514. Phone (919) 493-1451. TWX 510-920-0540.

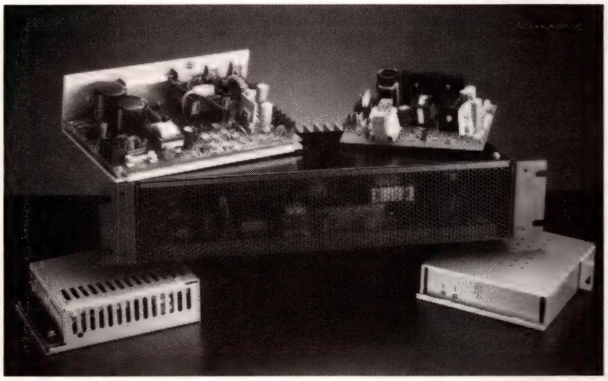
Circle No 414

CROSS COMPILER

- *Generates efficient code for 8051 family of μCs*
- *Supports internal bit operations*

AVPAS51 version 3.0 is an optimizing Pascal cross compiler for the 8051 family of μCs. The language is a dialect of Pascal that is closely matched to the architecture of the

Switching Power Supplies, light, small, efficient



Wells-Gardner's family of Switching Power Supplies give OEM designers a selection from among the lightest, most efficient and smallest switching power supplies on the market today.

Standard units include the 30 Watt Tron series, 60 watt Delta series, 72 watt Beta series, 138 Watt Gamma series, and 480 Watt Centry Circuit™ Theta series.

WELLS-GARDNER ELECTRONICS CORPORATION
2701 N. Kildare, Chicago, IL 60639
312/252-8220 TELEX: 25-3286

SERVING CONSUMER AND INDUSTRIAL ELECTRONICS FOR MORE THAN HALF A CENTURY

CIRCLE NO 54

Tauber and Panasonic. For Selection and Service.

When you need batteries, call Tauber. You'll have a wide selection of Panasonic batteries to choose from. And you'll get immediate off-the-shelf delivery. With our flexible value-added design and production capabilities, you can get custom packs built to your exact specifications. At Tauber Electronics, you'll be assured of responsive, personal attention.
Call today and learn more.

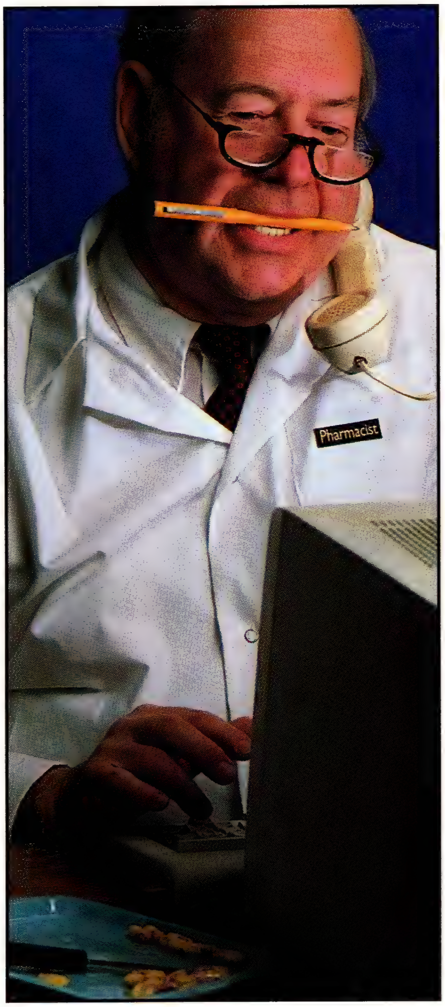
Panasonic®

TAUBER ELECTRONICS INC.

4901 Morena Blvd., ste. 314
San Diego, CA 92117 619/274-7242
FAX 619/274-2220; LA 213/416-9000
OC 714/667-0177; N. CA 408/737-9408

CIRCLE NO 55

The Multibus™ I host adapter pharmacists recommend most.



It's made by NCR, who helped develop SCSI. And we're confident if the pharmacists who use the NCR TOWER® knew our host adapter was an integral part of their system, they'd recommend it. Because NCR TOWER is the central processing unit trusted by many pharmacies nationwide – not to mention credit unions, warehouses, pizza delivery systems and others who need a reliable, high-performance Multibus system.

Now this same proven host adapter is available to you. Adding SCSI expandability gives your customers a third option when the choice is between sticking with an overworked Multibus system or scrapping it entirely. It gives them the capacity for new peripherals – hard disk, tape, and optical disk storage – all working off the same bus. Integration is easier and one SCSI board saves both power and slots over separate host adapters for each interface.

NCR's Multibus I-to-SCSI host adapter is available now, from NCR OEM Sales and Marketing. Call 1-800-325-SCSI for technical data on this or any of NCR's other SCSI products.

NCR

NCR OEM Sales
and Marketing
1-800-325-SCSI

Multibus is a trademark of Intel Corp.
TOWER is a registered trademark of the NCR Corporation.

Multibus I-to-SCSI Host Adapter. From NCR.

CIRCLE NO 227

CAE & SOFTWARE DEVELOPMENT TOOLS

DISK MAINTENANCE

- *Works with two hard-disk drives*
- *Works with both MFM and RLL controllers*

Disk Technician+ runs on the IBM PC, PC/XT, PC/AT, and compatibles. The disk-maintenance software package provides automated daily, weekly, and monthly testing procedures that prevent failures and recover data from damaged sectors on both hard and floppy disks. The program works with both MFM and RLL controllers, and with PC/AT 1.2M-byte floppy-disk drives. You can use one or two hard drives. The program reads from and writes to every individual bit in the hard-disk partition under test, using proprietary algorithms that can detect marginal bits, predict potential failures, and correct these failures if they occur. The package provides two formatting procedures: a nondestructive formatter for PC/AT-type machines, with adjustable interleaving to maximize system speed; and a destructive, low-level formatter with adjustable interleaving for PC/XTs, PC/ATs, and compatibles. You can retain or ignore the disk-manufacturer's bad-track table, and can add bad track or sectors at any time, nondestructively. The package also includes the SafePark memory-resident program, which automatically moves the heads to a safe zone if there is no hard-disk activity for a user-specified period within 1 to 15 sec. $129.95

Prime Solutions, 1940 Garnet Ave, San Diego, CA 92109. Phone (619) 274-5000.

Circle No 410

SPECTROSCOPY TOOL

- *Automates the acquisition and analysis of spectroscopy data*
- *Handles ultraviolet, visible, infrared, and other data*

The Spectrochart-PC software package automates the acquisition and analysis of spectroscopic data. Using the vendor's Adalab-PC data-acquisition board and an IBM PC or compatible, you can record and analyze voltage signals from the recorder output of any type of spectrometer, including those that operate with ultraviolet, visible, or infrared radiation as well as those that work with fluorescence, reflectance, atomic emission, or atomic absorbtion. You can analyze as many as 100 standard or unknown samples in any sequence. The program will record a single value for each sample, or, for kinetic studies, will provide each with multiple, timed values. The graphics routines can plot multiple samples, kinetic curves, or spectra in windows to 640×200 pixels max. You can select the position, size, background color, X and Y scale factors, and labels for each graph. You can display the value of a point by moving the cursor along the curve to that point. $595.

Interactive Microware Inc, Box 139, State College, PA 16804. Phone (814) 238-8294.

Circle No 411

CAE FOR MAC

- *Provides schematic entry, layout, and routing modules*
- *Can translate Gerber files to PostScript format*

The EDS-I electronic-design software system runs on the Apple Macintosh II. The schematic-capture module lets you generate schematics, using both standard and user-defined component libraries, and automatically produces a net list and a parts list. The layout module can handle pc-boards as large as 32×32 in. and provides zoom and pan features, auto-tooling extraction, multilayer editing, and Gerber photoplotting files. The autorouting module accepts the net list and parts list as input, lets you define routing parameters and options as well as keep-out areas, and lists unfinished nets. The Gerber translator module lets you convert Gerber files created by other systems into the electronic design software's internal format, or Gerber files produced by the software into PostScript files for use by high-resolution graphics printers in the Linotronics 300/500 series so that you can check the photoplot drawings before committing them to film. You do not have to order all the modules, but rather, can select just those that you need. Full system, around $1500.

Vamp, 6753 Selma Ave, Los Angeles, CA 90028. Phone (213) 466-5533. TWX 650-262-3069.

Circle No 412

CASE TOOLS

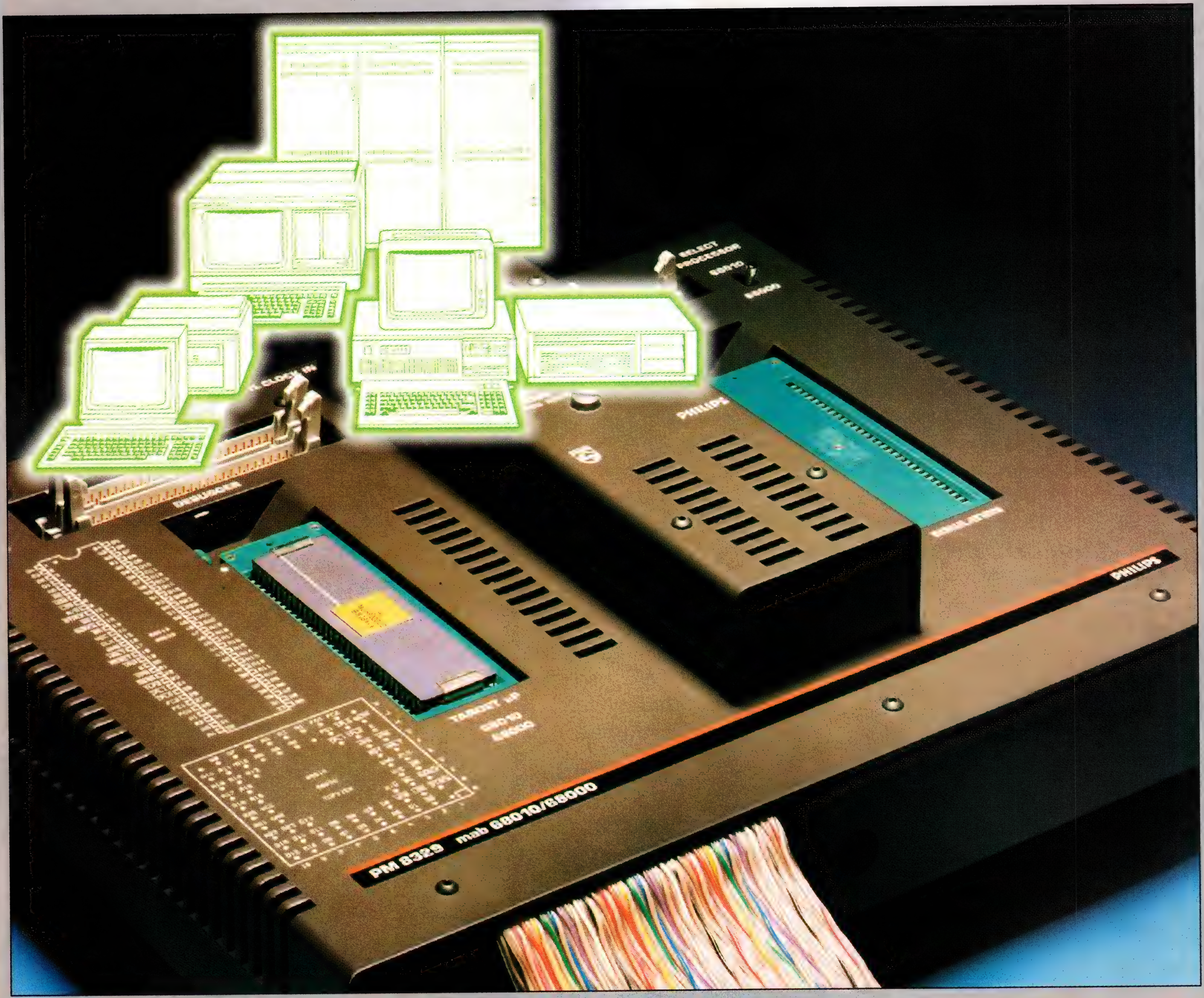
- *Help you document and examine multiple-module C programs*
- *Run on IBM PCs under MS-DOS*

The C Documenter and C Scan utilities for the IBM PC and compatibles ease the task of documenting and examining programs written in the C programming language. Where such programs are subdivided into separate subsystems, C Documenter generates a set of four reports containing cross-reference information, such as which modules or functions are called by other modules or functions. You can use the reports to define the interface between two program subsystems, which is advantageous when differ-

FLUKE AND PHILIPS – THE GLOBAL ALLIANCE IN TEST & MEASUREMENT

FLUKE®

PHILIPS



Looking for total 68000 development ability?

Then look to one of the world's leading suppliers of the 68000 microprocessor and peripheral chips: Philips – parent company of Signetics.

And to make sure we keep that lead, we have one of the broadest ranges of 68000 support tools to choose from. Three development systems, for example: the two-user PEDS; the multi-user PMDS 2 and the PC-based PMDS 3.

A Compiler Package, PCP, featuring a cross-software family of assemblers and compilers that use standard language definitions, and even allow mixing of languages. And HLL debuggers that allow you to debug your program as it runs in your target at the same level of 'abstraction' as the program was written in, e.g., C or PASCAL. You can even choose your host: PEDS, PMDS 2, PC-AT or VAX with complete source compatibility.

Moreover, as Philips is one of the world's largest manufacturers and users of micro-controllers, microprocessors and development tools, you will be looking to a single supplier who understands all your needs perfectly.

For further information, call your local supplier: **Austria*** (222) 629141, **Belgium** (2) 5256692/94, **Denmark*** (1) 572222, **Finland*** (0) 5257225, **France** (1) 49428080, **Germany** (561) 5010, **Great Britain** (223) 358866, **Ireland** (1) 952501, **Italy*** (39) 3635240/8/9, **Netherlands** (13) 352455, **Norway*** (2) 680200, **Portugal*** (1) 683121, **Spain*** (1) 4042200, **Sweden** (8) 7821800, **Switzerland** (1) 4882211.

***For Philips products only.**

For countries not listed, write to: Philips I&E, T&M Department, Building HKF, 5600 MD Eindhoven, The Netherlands.

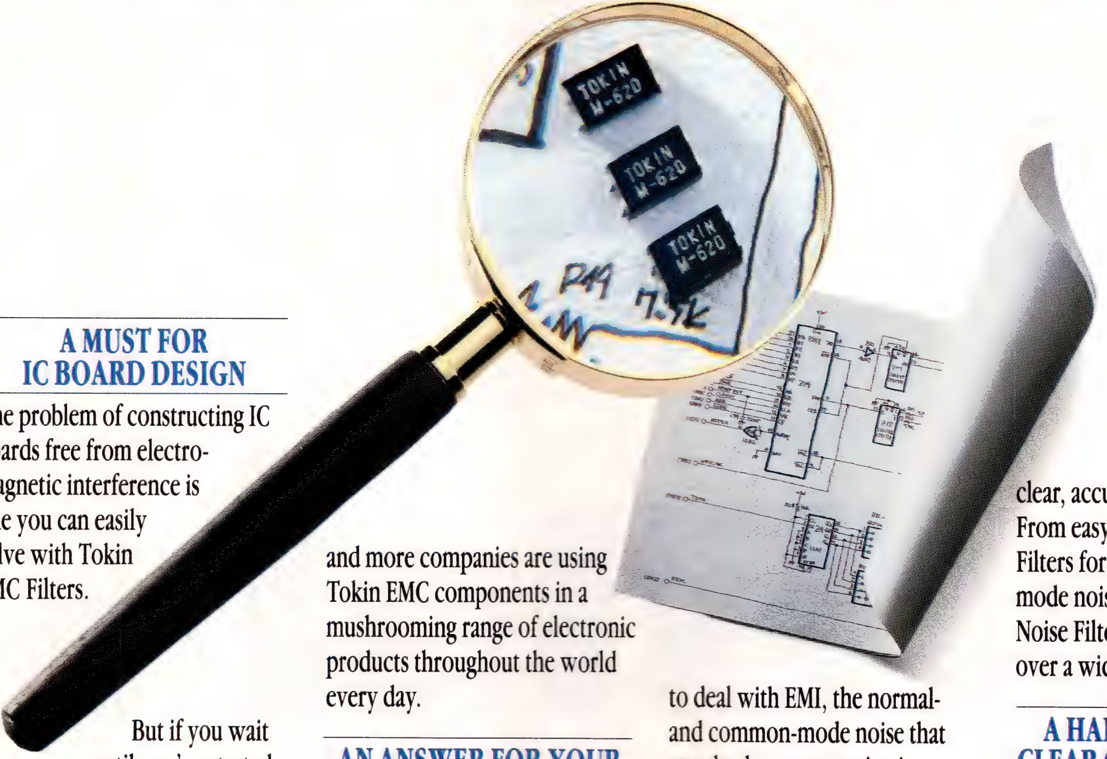
ADVANCED TECHNOLOGY
MADE TO MEASURE

PHILIPS

PHILIPS

TOKIN TECHNOLOGY UPDATE

Eliminate the noise from your design.



A MUST FOR IC BOARD DESIGN

The problem of constructing IC boards free from electromagnetic interference is one you can easily solve with Tokin EMC Filters.

But if you wait until you've started designing the board, it's already too late; it's something you need to consider *before* you begin. The Tokin EMC Chip Filters above are a good example. By including them in the IC design from the start, the designer can create an IC board that enables the end user to enjoy the full, unrestricted potential of the board's performance. That's why more and more companies are using Tokin EMC components in a mushrooming range of electronic products throughout the world every day.

AN ANSWER FOR YOUR EVERY DIGITAL NEED

Digital electronics are changing the shape of the world we live in, in more ways than one. And to deal with EMI, the normal- and common-mode noise that attacks data communications terminals and digital equipment, Tokin has come to the rescue with an incomparable lineup of EMC data line filters that deliver clear, accurate data transmission. From easy-to-mount EMC Chip Filters for normal- and common-mode noise absorption, to DIP Noise Filters for high impedance over a wide frequency range.

Specifications (DIP Noise Filters)

Model	Circuit	Rated Current per Line (mA)
D-03C/ D-03C1	8 circuits; Common-mode	100
D-05N1	8 circuits; Normal-mode	100
D-07C1	8 circuits; Common-mode	300
D-08C2	4 circuits; Common-mode	2,300
D-08C2A	4 circuits; Common-mode	500
D-16C	4 circuits; Common-mode	100
D-20C	8 circuits; Common-mode	500
D-40C	3 circuits; Common-mode	300
D-42C	5 circuits; Common-mode	300
D-45C	8 circuits; Common-mode	300
D-47C	10 circuits; Common-mode	300
D-55C	5 circuits; Common-mode	300
D-58C	8 circuits; Common-mode	300

Specifications (EMC Chip Filters)

Model	Circuit	Frequency Range (MHz)	Impedance (Ω)	Rated Current (mA)
M608	1 circuit; Common-mode	5 ~ 200	≧300 (at 100MHz)	100
M614	1 circuit; Common-mode	5 ~ 100	≧700 (at 50MHz)	100
M620	1 circuit; Common-mode	5 ~ 50	≧1,000 (at 30MHz)	100
M720N	20 circuits; Normal-mode	50 ~ 300	≧50 (at 200MHz)	50

A HALF-CENTURY OF CLEAR COMMUNICATION

Tokin stands for reliability you can count on, and all Tokin EMC components are backed by 50 years of intense work in developing and manufacturing communications and electronics materials and devices. From power line filters to noise simulators and other measuring equipment and facilities, Tokin offers a vast selection of products and services to provide unprecedented communication clarity. Call us for details.

Please see us at

Electro/88®
Electronic Show and Convention
May 10-12/Boston, Massachusetts
#2711/2713

Tokin

Tokin Corporation
Head Office: Hazama Bldg., 5-8, Ni-chome, Kita-Aoyama, Minato-ku, Tokyo 107, Japan **Tel:** Tokyo (03) 402-6166 **Fax:** Tokyo (03) 497-9756
Telex: 02422695 TOKIN J

Tokin America Inc.
155 Nicholson Lane, San Jose, California 95134, U.S.A. **Tel:** 408-432-8020 **Fax:** 408-434-0375
Chicago Branch: Presidents Plaza 1, Suite 200N, 8600 W. Bryn Mawr, Chicago, IL 60631 **Tel:** 312-380-0030 **Fax:** 312-693-8334

München Liaison Office
Elisabethstraße 21, 8000 München 40, Bundesrepublik Deutschland **Tel:** (089) 271 75 22 **Fax:** (089) 271 75 67 **Telex:** 5 24 537 tokin d

You can reach our agents by phone: London 01-837 2701; Paris 1-45 34 75 35; Milan (0331) 678.058; Munich (089) 5164-0; Seoul (02) 777-5767; Taipei (02) 7311425; Hong Kong 3-315769; Singapore 747-8668

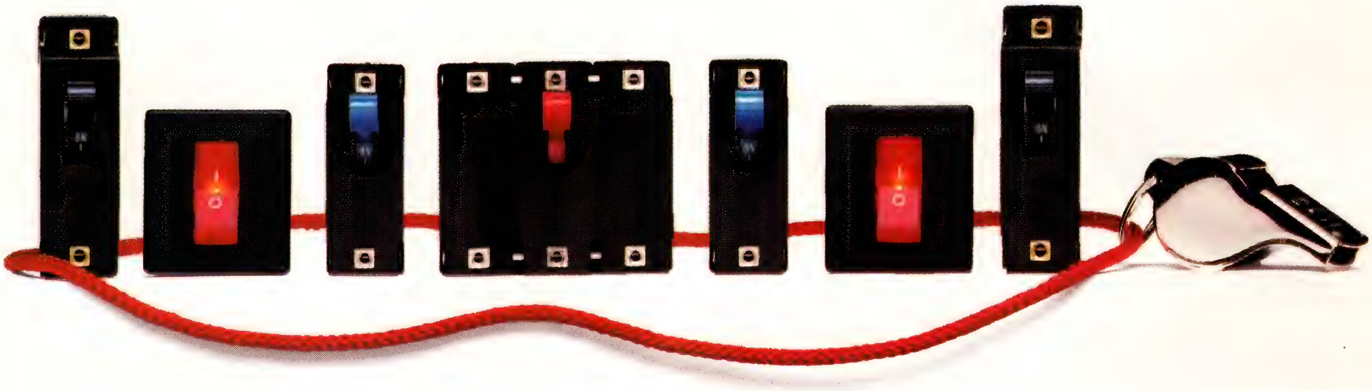
CIRCLE NO 230

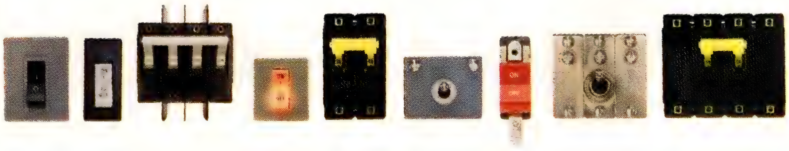
SIMPLY THE BEST DEFENSIVE LINE IN THE GAME.

When it comes to depth, diversity, and a proven winning record, no other line of circuit breakers can compare with ours. The Airpax team is your source for fast response and reliable performance in your choice of more styles, configurations and ratings to meet your specific needs.

We've been tackling the toughest applications for more than thirty years. Chalking up milestone victories such as twenty years of uninterrupted MIL-C-39019 approval in Type AP electromagnetic circuit breakers. Blitzing international markets with the VDE-approved and rail-mount magnetic circuit breakers. Continually striving through innovation to keep you, the Airpax customer, at the forefront of circuit breaker technology.

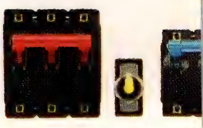
Draft the best defensive players into your design. Contact Airpax Corporation, Cambridge Division, Woods Road, Cambridge, MD 21613. (301) 228-4600. Telex: 6849138, Fax: (301) 228-8910. A North American Philips Company.





AIRPAX®

CAMBRIDGE DIVISION



See us at Electro Booth No. 1351

CIRCLE NO 231

comes in a hermetic 32-pin, triple-wide DIP. J grade with ±1-LSB performance, $195; K grade with ±½-LSB performance, $295 (100).

Analog Devices, Literature Center, 70 Shawmut Rd, Canton, MA 02021. Phone (617) 935-5565. TWX 710-394-6577.

Circle No 363

FIFO REGISTERS

- *Has 16-word×4-bit silicon gate CMOS device*
- *40-MHz data-rate capability*

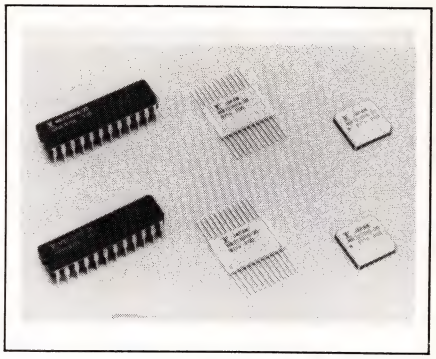
Except for their capacities, the 74HC/HCT40105 16-word×4-bit and the 74HC/HCT7030 64-word×9-bit FIFO registers are functionally identical. The devices feature a 40-MHz typ burst-in/burst-out data rate without flags, and a very low power consumption (essentially zero in the idle mode). Other features include independent shift-in/shift-out controls and input-ready and output-ready status indicators. The FIFOs are cascadable in depth and expandable in word width; they can operate at 30 MHz typ with flags. 74HC/HCT40105, $2.85; 74HC/HCT7030, $35 (100).

Signetics, Box 3409, Sunnyvale, CA 94088. Phone (408) 991-2000.

Circle No 364

FAST PROMs

- *Registered outputs*
- *20-nsec clock-access times*

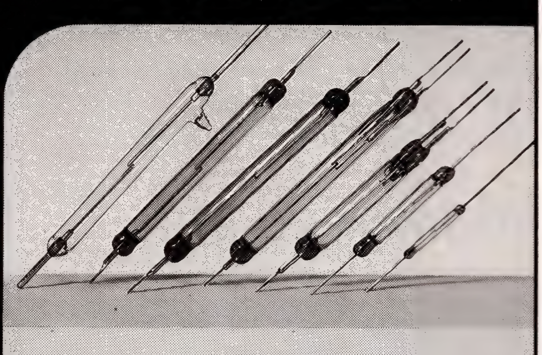


Organized as 8-bit-wide devices, the MB7226, MB7232, and MB7238 PROMs provide 4-, 8-, and 16-bit-wide storage capacities, respectively. The built-in register of these devices latches the output data, eliminating the need for an external register. Each of the three PROMs features a 20-nsec access time; 25-nsec versions are also available. You can program the register's initial contents to any 8-bit value when programming the rest of the PROM's contents. The PROMs are TTL compatible and operate from a 5V supply. The package options include a 24-pin ceramic DIP, a 24-pin ceramic flatpack, and a 28-pin LCC. From $5.25 to $17.

Fujitsu Microelectronics Inc, 3320 Scott Blvd, Santa Clara, CA 95054. Phone (408) 562-1000.

Circle No 365

GÜNTHER



Additional products:
high voltage Reed-Relays, SIP and DIP Relays
with dry or mercury wetted reed contacts.

High Power Reed Switches

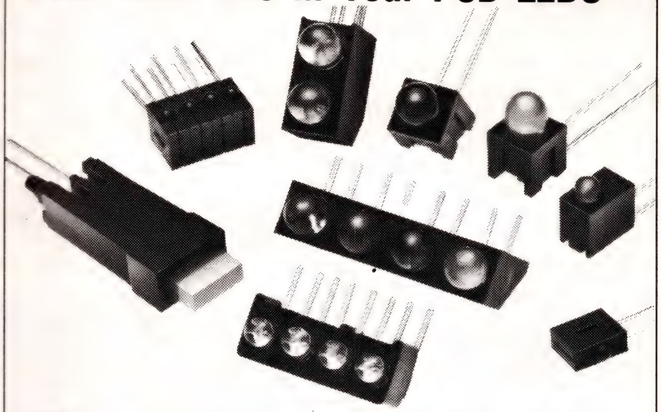
Günther offers a range of Reed Switches permitting high power performances in miniaturized sizes for all kinds of applications:

- **subminiature from C** pressurized switches up to 20 W switching power, with a glass body measuring only .10 dia × .59" length (type 3336),
- **high voltage** switches up to 14 KV breakdown voltage and 10 KV switching voltage,
- **high current** switches with switching current up to 5 amps,
- **power** switches form A and form B with switching power up to 100 W, and form C up to 60 VA.

spectron
glass and electronics inc.
595 Old Willets Path
Hauppauge, N.Y. 11788
Tel. (516) 582-5600 · Telex 968.296

CIRCLE NO 52

LEDTRONICS
Puts More Life in Your PCB LEDS



We make them in all SIZES, all INTENSITIES, all VOLTAGES, all CONFIGURATIONS, for all types of APPLICATIONS.

We have them in BICOLORS & TRICOLORS, in 5 volt BLINKING, in SUNLIGHT VISIBLE, in INFRAREDS.

And we deliver them FAST....FASTER than our competitors.

Let the 'WIZARDS OF LIGHT' at LEDTRONICS supply you with the information and SAMPLES you need on your PCB LED requirements.

"Put More LIFE in Your LIGHT"

LEDTRONICS, INC.
4009 Pacific Coast Hwy., Torrance, CA 90505

Tele 213-676-7996
Fax 213-676-0108
Tlx 494-5454

CIRCLE NO 53

High-Rel ACL
Reporting for Duty
RCA
CD54AC00F3A
5962-87549O1CA
Advanced CMOS Logic is the newest reinforcement in the world's broadest High-Rel CMOS product line.

If you're designing tactical military systems, it's more logical than ever to come to GE Solid State for all your High-Rel logic needs. Because we've just introduced well over 50 ACL logic devices that give you the speed of FAST† plus all the benefits of CMOS. These devices, fully compliant to Mil-Std-883 Rev C, are available in both AC and ACT (TTL-compatible) versions.

Call toll-free, 800-443-7364 ext. 23

In Europe, call: Brussels, (02) 246-21-11; Paris, (1) 39-46-57-99; London, (276) 68-59-11; Milano, (2) 82-291; Munich, (089) 63813-0; Stockholm (08) 793-9500.

Reporting for Duty

- Two Hex Inverter/Buffers*
- Three Quad 2-Inputs*
- Three Dual Flip-Flops
- Two 3- to 8- Line Decoder Demultiplexers*
- Two Quad 2-Inputs Multiplexers
- One 4-Bit Full Adder with Fast Carry
- Two 4-Bit Binary Counters
- Two Synch 4-Bit Binary Up-Down Counters
- Two Octal Buffer Line Driver 3-State*
- Two Octal BUS Transceiver 3-State*
- One Quad 2- to 4- Line Data Selector
- One 9-Bit Odd/Even Parity Generator/Checker
- Three Octal Buffer Line Driver 3-State (Inverting)*
- One Octal Transparent Latch 3-State
- One Octal D-Type Flip-Flop 3-State*
- One Octal Transparent Latch 3-State(Inverting)
- One Octal InvertingTransparent Latch 3-State

*Standard Military Drawings available

† FAST is a trademark of Fairchild Semiconductor Corp.

*

GE Solid State

GE/RCA/Intersil Semiconductors
Three great brands. One leading-edge company.

*Trademark of General Electric Company, U.S.A., not connected with the English Company of a similar name.

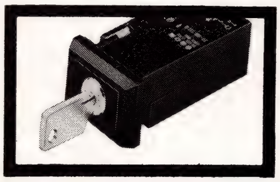
Sealed industrial power switches with
UP-FRONT MOUNTING!

sealed pushbuttons, keylocks & mushrooms

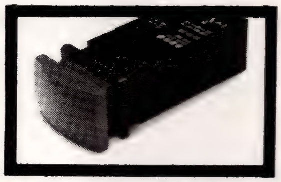
10 AMP; 380 VOLTS, AC

Series 22 industrial power pushbuttons and keylocks are easy to mount from the front of the panel by **one person**—just tighten two screws! Designed for use in harsh environments, they feature a front sealed to IP65 specifications; a ruggedized, shock proof case which resists chemicals and meets IP20 standards. Another plus...rear connections are completely insulated against inadvertent contact. Screw terminals may be converted to .250 Q.C. terminals and snap-on insulator sleeve is available for Q.C. protection. Also, they fit panels 1.5 to 6 mm thick and operate in a broad temperature range: -25° to +85° C.

For superbright illumination, select neon, T 1¾ midget grooved lamps or T 1¾ based multichip LED's in red, yellow, or green. Choose from three bezel shapes and eight lens colors for style. All Series 22 switches are UL, CSA, VDE and SEV listed.



Keylock



Mushroom pushbutton

eao

EAO SWITCH CORPORATION

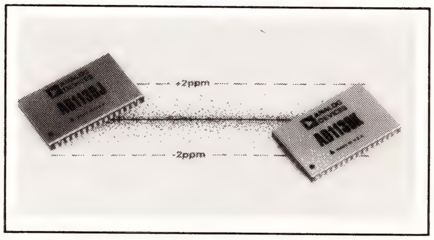
P.O. BOX 552, MILFORD, CT 06460. 203/877-4577
TELEX: EAOSWITCHMFRD 964347. FAX: 203/877-3694

ELECTRO Booth #242

The offset voltage is ±1 mV max, and the bias current is 50 pA max. The open-loop gain is 96 dB, and the slew rate is 6V/μsec min. The device has FET inputs, and its class A/B output stage minimizes crossover distortion. The TO-3 package is electrically isolated for direct mounting on a heat sink. The device is available in three performance grades and two temperature ranges. From $28.95 (100).

Burr-Brown, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TLX 666491.

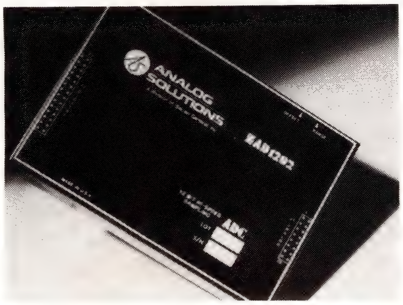
Circle No 362



HYBRID DAC

- *Adustment-free 18-bit accuracy*
- *±½-LSB differential and integral nonlinearity*

The AD1139 D/A converter has voltage- and current-output data latches, an internal reference, an output amplifier, and application resistors for output ranging. You don't have to make adjustments to achieve the specified 18-bit accuracy, and the device has a guaranteed differential and integral nonlinearity of ±½ LSB. Voltage output ranges are 0 to 5V, 0 to 10V, ± 5, and ±10V. You can also select current outputs of −1 mA and ±0.5 mA. The settling time is 6 μsec for a single LSB change, and the full-scale settling time is 40 μsec. The device's high-stability internal reference is available through a built-in buffer for use as an external reference. Data bits are presented to the DAC via a single 18-bit bank of parallel, 5V CMOS-compatible latches, which ease the interface to processor buses. The device requires 5V and ±15V supplies. It



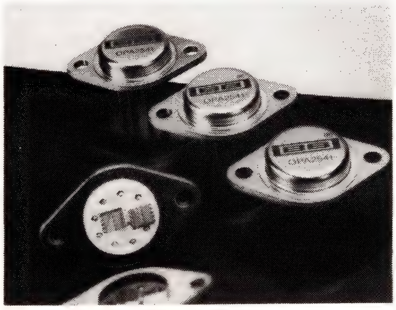
12-BIT ADC

- *2-MHz throughput*
- *Operates from ±15V and 5V supplies*

The completely shielded, integrated ZAD1202 module is a 12-bit sampling A/D converter that minimizes the number of converters needed in multichannel digitizing systems. It has a 2-MHz throughput, which includes the S/H operation and the A/D conversion. The harmonic distortion is −74 dB from dc to 500 kHz, and −68 dB from 500 kHz to 1 MHz. The device's S/N ratio is −70 dB min at 100 kHz, and its relative accuracy is ±¾ LSB max. The gain and offset of the module is adjustable. $449 (100).

Analog Solutions, 85 W Tasman Dr, San Jose, CA 95134. Phone (408) 433-1900.

Circle No 361



DUAL-POWER OP AMP

- *Output currents to 5A*
- *Power supplies to ±40V*

Containing two monolithic power-amplifier chips, the OPA2541 op amp can deliver 5A continuous from ±10 to ±40V supplies.

THE MOMENT OF TRUTH FOR PLENCO 06582—

500 HOURS AT 285°C.

Today's tough product liability laws, along with tightened manufacturing standards, demand more accurate product performance information.

Plastics Engineering Company, Sheboygan, Wisconsin, manufacturers of Plenco thermoset molding compounds, is concerned that temperature/stress ratings for engineering thermoplastics may not reflect actual performance under load at high temperatures. Current test methods either measure strength after a heated part has cooled or measure the temperature at which a test sample deflects 0.010 in.

Plastics Engineering Company conducted a test of twelve materials' ability to perform under continued load at high temperature to determine a heat stress rating. The results of the heat and stress tests of nine engineering thermoplastics showed catastrophic failure at temperatures significantly lower than expected. The engineering-grade phenolic was a different story.

Plenco 06582 was subjected to the highest heat possible in a standard laboratory test oven–285°C–for 500 hours. The test sample deflected 4° under continued stress. **Plenco 06582** withstood the stress and more heat, far longer. And it costs a fraction of the engineering thermoplastics.

The results of these tests should be reviewed by engineers, designers, and manufacturers – anyone who specifies plastic parts. For a detailed report write or give us a call at (414) 458-2121. You'll be glad you did instead of wish you had.

thermoset plastic performance for over 50 years.

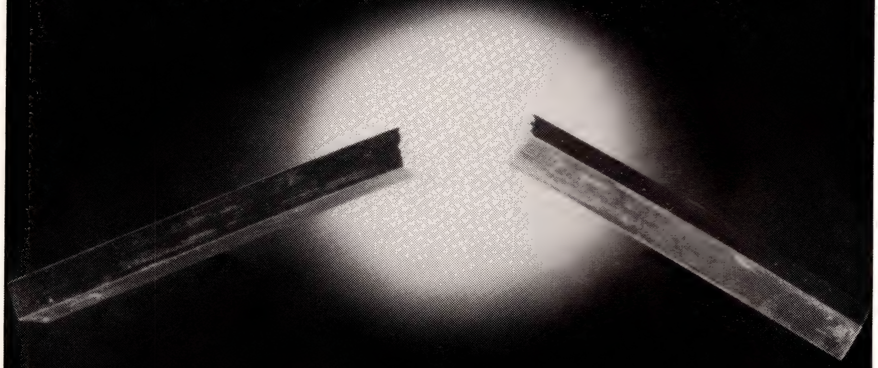
PLENCO
THERMOSET PLASTICS

PLASTICS ENGINEERING COMPANY
Sheboygan, WI 53081

Through Plenco research... a wide range of ready-made or custom-formulated phenolic, melamine-phenolic, alkyd and polyester thermoset molding compounds, and industrial resins.

CIRCLE NO 74

THE MOMENT OF TRUTH
FOR POLYPHENYLENE SULFIDE–
3 HOURS AT 255°C.



Today's tough product liability laws, along with tightened manufacturing standards, demand more accurate product performance information.

Plastics Engineering Company, Sheboygan, Wisconsin, manufacturers of Plenco thermoset molding compounds, is concerned that temperature/stress ratings for engineering thermoplastics may not reflect actual performance under load at high temperatures. Current test methods either measure strength after a heated part has cooled or measure the temperature at which a test sample deflects 0.010 in.

Plastics Engineering Company conducted a test of twelve materials' ability to perform under continued load at high temperature to determine a heat stress rating. The results of the heat and stress tests of nine engineering thermoplastics showed catastrophic failure at temperatures significantly lower than expected.

Polyphenylene sulfide (40% glass filled), under this test method, demonstrated a maximum temperature rating of 245°C compared to its published deflection temperature under load (ASTM D648) rating of 260°C. Polyphenylene sulfide fractured after 3 hours of exposure to 255°C. In fact, all the thermoplastic compounds tested resulted in maximum temperature ratings significantly below their published deflection temperature under load.

The results of these tests should be reviewed by engineers, designers, and manufacturers – anyone who specifies plastic parts. For a detailed report write or give us a call at (414) 458-2121. You'll be glad you did instead of wish you had.

thermoset plastic performance for over 50 years.

PLENCO
THERMOSET PLASTICS

PLASTICS ENGINEERING COMPANY
Sheboygan, WI 53081

Through Plenco research... a wide range of ready-made or custom-formulated phenolic, melamine-phenolic, alkyd and polyester thermoset molding compounds, and industrial resins.

CIRCLE NO 73

scratchpad memory with 32-bit floating-point products such as the TMC3200 floating-point arithmetic unit, the TMC3201 floating-point multiplier, and the TMC3210 floating-point divider. Fully TTL compatible, the device operates from a 48-nsec clock and uses just 30 mA max of current when operating in the commercial temperature range. It comes in a 48-pin ceramic DIP. Commercial-grade version, $29; military-grade version, $61 (1000).

TRW, LSI Products Div, Box 2472, La Jolla, CA 92038. Phone (619) 457-1000.

Circle No 359

PREAMPLIFIER

- *Dual-channel preamplifier for Inductosyns*
- *Internally matched gain resistors*

The IPA-15805 preamplifier raises the low-level output of an Inductosyn to 2V rms, thus providing the needed drive for an Inductosyn-to-digital converter. The hybrid features high gain, together with matched gain and matched phase. You can use the device without trimming, or for maximum circuit accuracy, you can trim it externally for both gain and phase. Available in a small, 18-pin hermetically sealed package, the device has an operating temperature range of −55 to 125°C. $148. Delivery, stock to 90 days.

ILC Data Device Corp, 105 Wilbur Pl, Bohemia, NY 11716. Phone (516) 567-5600. TWX 310-685-2203.

Circle No 360

cuitry to limit the current in the power transistor and to protect the supply against repeated output overcurrent, overvoltage, and undervoltage conditions. Both devices also provide soft-start circuitry. Around $1.46 (1000).

SGS-Thomson Microelectronics, Via C Olivetti 2, 20041 Agrate Brianza, Italy. Phone (039) 65551. TLX 330131.

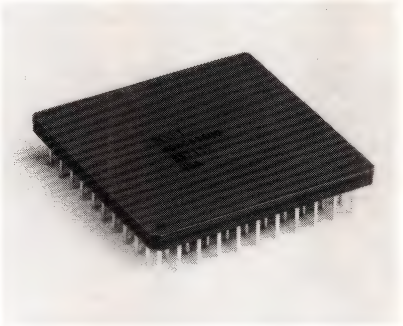
Circle No 356

SGS-Thomson Microelectronics, 1000 E Bell Rd, Phoenix, AZ 85022. Phone (602) 867-6100. TLX 249976.

Circle No 357

MULTIPLEXED DAC

- *250-MHz, 8-bit performance*
- *Five TTL/CMOS-compatible input buses*



The HDAC51600 250-MHz, 8-bit multiplexed D/A converter has five TTL/CMOS-compatible input buses. It simplifies system designs that combine high-speed analog inputs with TTL or CMOS logic. Included on chip are a voltage reference, data latches, timing and control logic, a 5:1 multiplexer, and a video DAC. Synchronization, blank, bright, and force-high controls are available. The device also provides a clock output for system-memory control. When used with CMOS memory, the converter creates a high-speed system that provides cost- and power-savings, compared with designs that use discrete video DACs and ECL memories. The device's linearity is guaranteed to ±½ LSB, and the slew rate is 525 V/μsec min. The outputs of the device can drive either 50 or 75Ω loads. In a 46-pin pin-grid array, $98.75 (100).

Honeywell Inc, Signal Processing Technologies, 1150 E Cheyenne Mountain Blvd, Colorado Springs, CO 80906. Phone (719) 540-1000.

Circle No 358

REGISTER FILE IC

- *Provides three ports*
- *Features 20-MHz read/write capability*

The TMC3220 three-port register file is a specialized memory IC that features one write and two independent read ports. The IC features 20-MHz, asynchronous read/write capability. You may use it as a

Brooktree®

Brooktree Bt458. *Triple 8-bit color RAMDAC. Available in speeds from 80 MHz to 125 MHz.*

Sun Microsystems' Sun-4/260 Workstation with TAAC-1. *Provides pseudo color (8 bit) and true color (24 bit), with a choice of 256 colors or 16.8 million colors.*

Brooktree Corporation,
9950 Barnes Canyon Road,
San Diego, California 92121
1-800-VIDEO IC.

© Copyright Brooktree Corporation 1988.

CIRCLE NO 72

plify its use. Its high bit-jitter rejection also enhances overall stability. In a plastic DIP, $10; in a PLCC surface-mount package, $11 (10,000).

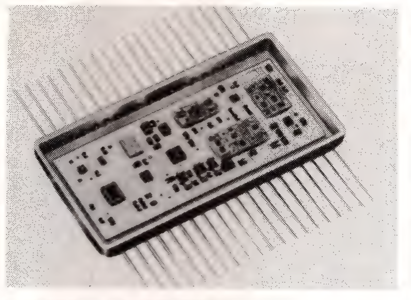
NEC Microelectronics Inc, Box 7241, Mountain View, CA 94039. Phone (415) 960-6000. TWX 910-379-6985.

Circle No 354

HYBRID 12-BIT ADC

- *Includes a track/hold amplifier*
- *Comes in a hermetic, 40-pin flat pack*

Encased in a hermetic, 40-pin flat pack for use in surface-mount applications, the ADC-00302 hybrid includes a 12-bit A/D converter, a track/hold amplifier, data registers, 3-state output buffers, and timing circuits. The IC provides nine bipolar/unipolar jumper-selectable analog input ranges, and its output registers and 3-state buffers interface to most CPUs. Because of its self-contained timing, the device requires only an encode command to start its conversion cycle. Its other characteristics include 68-dB min harmonic reduction, a 65-dB min signal-to-noise ratio, and a 0.025%-FSR (feedback shift register) max linearity error. The vendor offers MIL temperature-range versions. From $750.



ILC Data Device Corp, 105 Wilbur Pl, Bohemia, NY 11716. Phone (516) 567-5600. TWX 310-685-2203.

Circle No 355

SWITCH-MODE ICs

- *Enable switch-mode supplies with output to 200W*
- *Use low-cost transformers to provide input/output isolation*

Operating on a master-slave principle, the TEA2170 and TEA2164 provide regulation and protection functions for isolated switch-mode power supplies with outputs as high as 200W. They are suited for use in low-cost power supplies for consumer products—for example, TV receivers, video recorders, and audio equipment. The devices let you isolate a supply's secondary side from the line input with a low-cost transformer. The TEA2164's ±1.5A output can directly drive power transistors at switching frequencies as high as 60 kHz. You can also synchronize the switching to an external frequency, such as the line-scan frequency of a TV set. The TEA2164 contains protection cir-

Color by

Sun Microsystems' Sun-4/260 workstation with the TAAC-1 Applications Accelerator lifts visualization capabilities to new heights. Brooktree provides the lift with four Bt458 RAMDACs small enough to fit on a single board. The result: Amazing detail in both pseudo and true color.

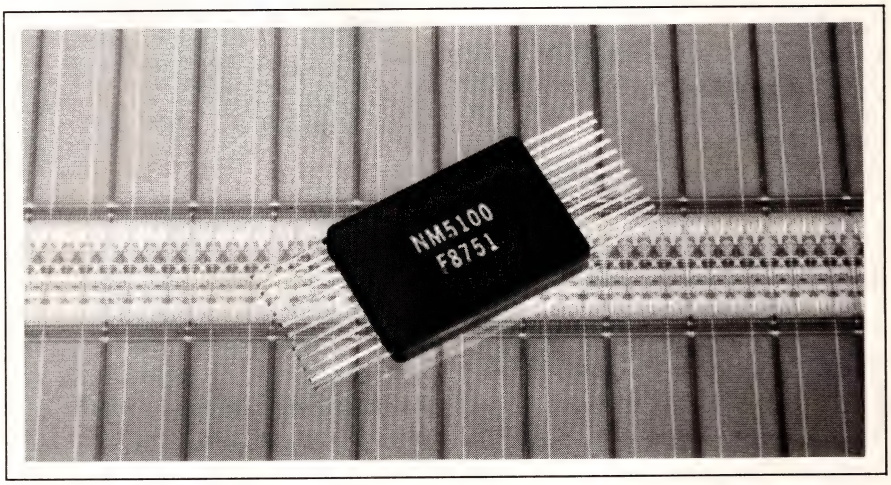
NEW PRODUCTS

INTEGRATED CIRCUITS

FAST STATIC RAM

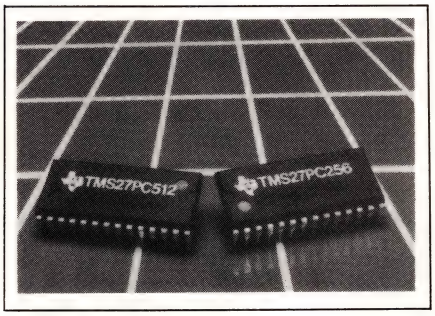
- *Available in 15- and 18-nsec speed grades*
- *10K and 100K ECL-compatible*

Organized as 262,144 words×1-bit, the NM5100 high-performance static RAM is compatible with 10K and 100K ECL I/O interfaces. The device is available in 15- and 18-nsec versions and operates from a supply voltage of −5V. The power dissipation is less than 1W. To meet the requirements of MIL-STD-883C, the device has 2000V electrostatic discharge protection. The latch-up immunity exceeds 200 mA. The device comes in either a 24-pin, 400-mil ceramic DIP or in a low-inductance 365×535-mil ceramic flatpack with a 30-mil lead pitch. 15-nsec version, $125; 18-nsec version, $96 (100).



National Semiconductor Corp, Box 58090, Santa Clara, CA 95052. Phone (408) 749-7400. TLX 346353.

Circle No 351



CMOS PROMs

- *One-time programmable*
- *Available in four densities*

Available in 64k-, 128k-, 256k-, and 512k-byte densities, the TMS27PC64, -27PC128, -27PC256, and -27PC512 CMOS PROMs feature high-speed performance comparable to NMOS devices and provide the added benefits of lower power dissipation and improved reliability. With device speeds ranging from 150 to 200 nsec, the PROMs are designed for systems that do not require the reprogrammability of EPROMs. Because the package used for these PROMs is windowless, the PROMs offer improved data integrity when compared with windowed EPROMs. The devices feature an active power dissipation of less than 220 mW. Depending on type, from $3.16 to $6.16 (100).

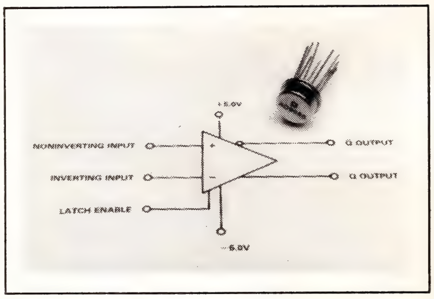
Texas Instruments, Semiconductor Group, SC-800, Box 809066, Dallas, TX 74380. Phone (800) 232-3200, ext 700.

Circle No 352

TTL COMPARATOR

- *High-speed operation*
- *Complementary TTL outputs*

Featuring a 7-nsec propagation delay, the AD9686 comparator provides a latch-enable control line with a 2-nsec setup time for high-speed voltage comparisons. It can detect high-speed voltage transitions in both analog and digital systems. The device has an input-offset voltage of 2 mV max that typically drifts less than 10 μV/°C over the −55 to +125°C temperature range. Other key specifications include a 4-μA input bias current and 85-dB common-mode rejection. The comparator comes in a TO-100 metal can, a 16-pin ceramic DIP, or a 20-terminal ceramic LCC. From $3 to $16 (100).



Analog Devices, Literature Center, 70 Shawmut Rd, Canton, MA 02021. Phone (617) 935-5565. TWX 710-394-6577.

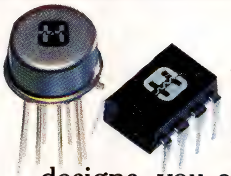
Circle No 353

DISK CONTROLLER

- *Single-chip, floppy-disk controller*
- *Compatible with standard data formats*

The μPD72067 single-chip, floppy-disk controller is compatible with industry-standard data formats, including IBM and Sony's European Computer Manufacturers Association format. The device incorporates write compensation and system clock-generation circuitry that sim-

Give your industrial controls a lift with our high-performance analog ICs.



When you put industry-proven Harris linear and data acquisition ICs into your control designs, you always come out ahead — in design time, cost, and product performance.

Just specify the functions you need. If it's industrial, we're in control. With a complete line of op amps — high-speed, low-power, precision or general purpose. Comparators. And analog switches.

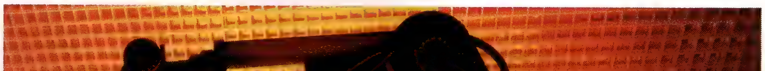
For data acquisition, choose our A/D and D/A converters, sample-and-hold amplifiers, and analog multiplexers.

Our Dielectric Isolation (DI) process means no latch-up, plus higher speed and performance characteristics.

Get Harris into your system.

Contact: Harris/MHS Semiconductor Sales Ltd., Eskdale Road, Winnersh, Wokingham, Berks, RG11 5TR, England.

We'll help handle your load.



FOR YOUR INFORMATION, OUR NAME IS

HARRIS

Harris Semiconductor: Analog - CMOS Digital
Gallium Arsenide - Semicustom - Custom

HARRIS

"What makes Harris ICs so much more reliable?"
"Industrial strength!"

©1987, Harris Corporation

NO

THIS IS NO ORDINARY 220-400 WATT OPEN FRAME POWER SUPPLY SERIES.

NO COMPROMISE IN DESIGN. This is not another flyback converter, it's the RMV/RMC/RMF series . . . with half-bridge rectification, mosfet switching & 70 KHz operation for superior performance and reliability.

NO LIMITATIONS . . . of standard features or component selection. Fully regulated auxiliaries (±0.5%); TTL compatible remote inhibit & remote sense are all standard.

Triac soft-start circuitry provides inrush current limiting.

NO MINIMUM LOAD REQUIRED. Auto preload circuitry maintains regulaton on the auxiliary outputs—regardless of main output load conditions.

NO NEED FOR EXTERNAL FILTERING. ACDC's RMV/RMC/RMF series has an on-board EMI filter which meets FCC Docket, Class A & VDE 0871, Class A.

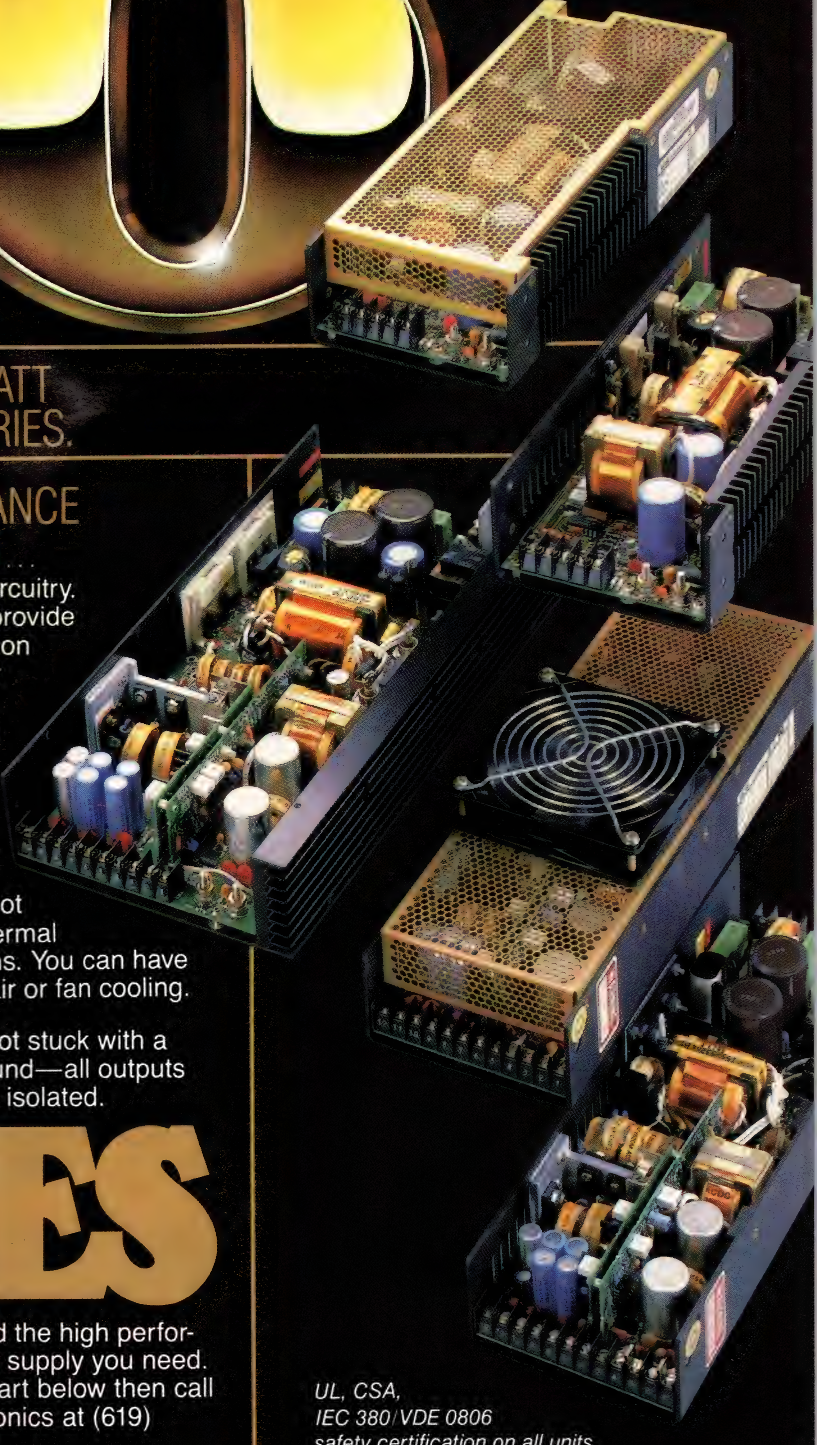
NO NUISANCE TRIPPING . . . of overload circuitry. MAGAMPS provide peak current on demand—for unequalled performance in drive & stepper motor applications.

NO. You're not limited by thermal considerations. You can have convection, air or fan cooling.

NO. You're not stuck with a common ground—all outputs are floating & isolated.

YES

You just found the high performance power supply you need. Check the chart below then call ACDC Electronics at (619) 439-4200.



UL, CSA,
IEC 380/VDE 0806
safety certification on all units

MODEL SELECTION CHART

WATTS	SINGLE RMC 301	MULTI RMV (Conv. cooled)	MULTI RMC (Air cooled)	MULTI RMF (Fan cooled)
220		■		
300	■	■	■	■
400			■	■

1600w 1500w 1000w 800w 750w 500w 400w 300w 220w 175w 135w 70w 40w 15w

ACDC's POWER OFFERING

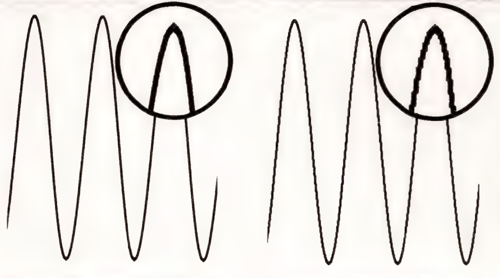
401 Jones Road, Oceanside, CA 92054
TEL: 619/757-1880. TLX: 350227. FAX: 619/439-4243

acdc electronics

CIRCLE NO 246

An Instrument is only as Good as its Output

Will the hardcopy output of your next instrument reflect the quality, precision and capability you build into it?



General Scanning's AR-100 and AR-40/41 800-dot resolution produces smooth waveforms.

200-dot waveforms, typical of most output printers, have ragged contours.

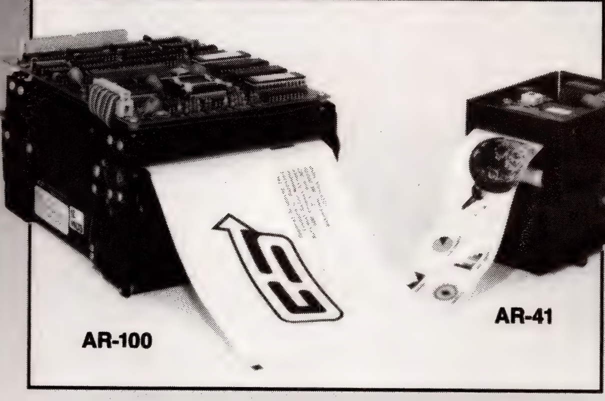
Instrument users get more than data from their printout . . . they also get a continuing impression of the overall quality and accuracy of the instrument that produces it.

Plots that can't keep pace with real-time events, that display rough, visible jaggies, that are limited in format and have noticeably lower resolution may adversely reflect on the quality of your instruments.

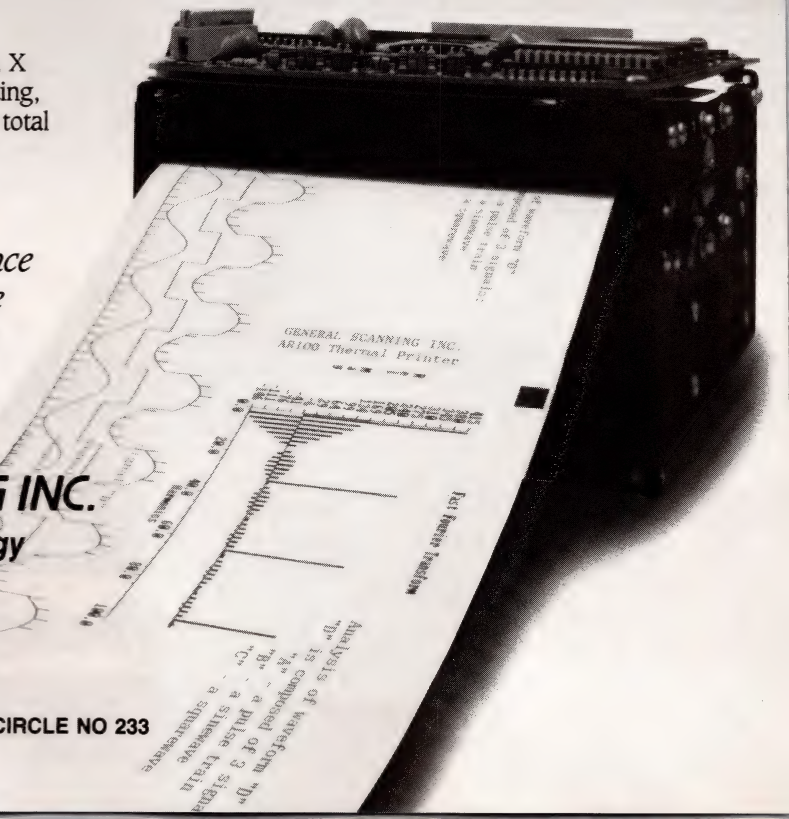
WHERE DO YOU GO FOR SMOOTH, HIGH-SPEED, HIGH-RESOLUTION RECORDING?

Only General Scanning's advanced 2 and 4 inch thermal array printer/plotters are designed specifically to produce records suitable for premium quality, precision instruments. They provide:

- Industry's highest resolution (800 dots/in) for maximum output quality.
- User-defined printing speeds from 1 mm/hr to 50 mm/sec (up to 650 characters/sec).
- Extensive character complement (246, including 96 ASCII); easy-to-add special and foreign sets for custom and international applications.
- Proprietary curve-smoothing software to enhance waveforms (real-time).
- Custom generation of background grids, special codes, X and Y orientation of alphanumerics and graphics printing, full interaction between all output modes, etc. provide total printing flexibility.
- Internal self-test routines, reducing QA and incoming inspection expenses inherent in similar products.



General Scanning, with 20 years of experience in building advanced thermal printers, is the leader in offering customers total application and engineering support.



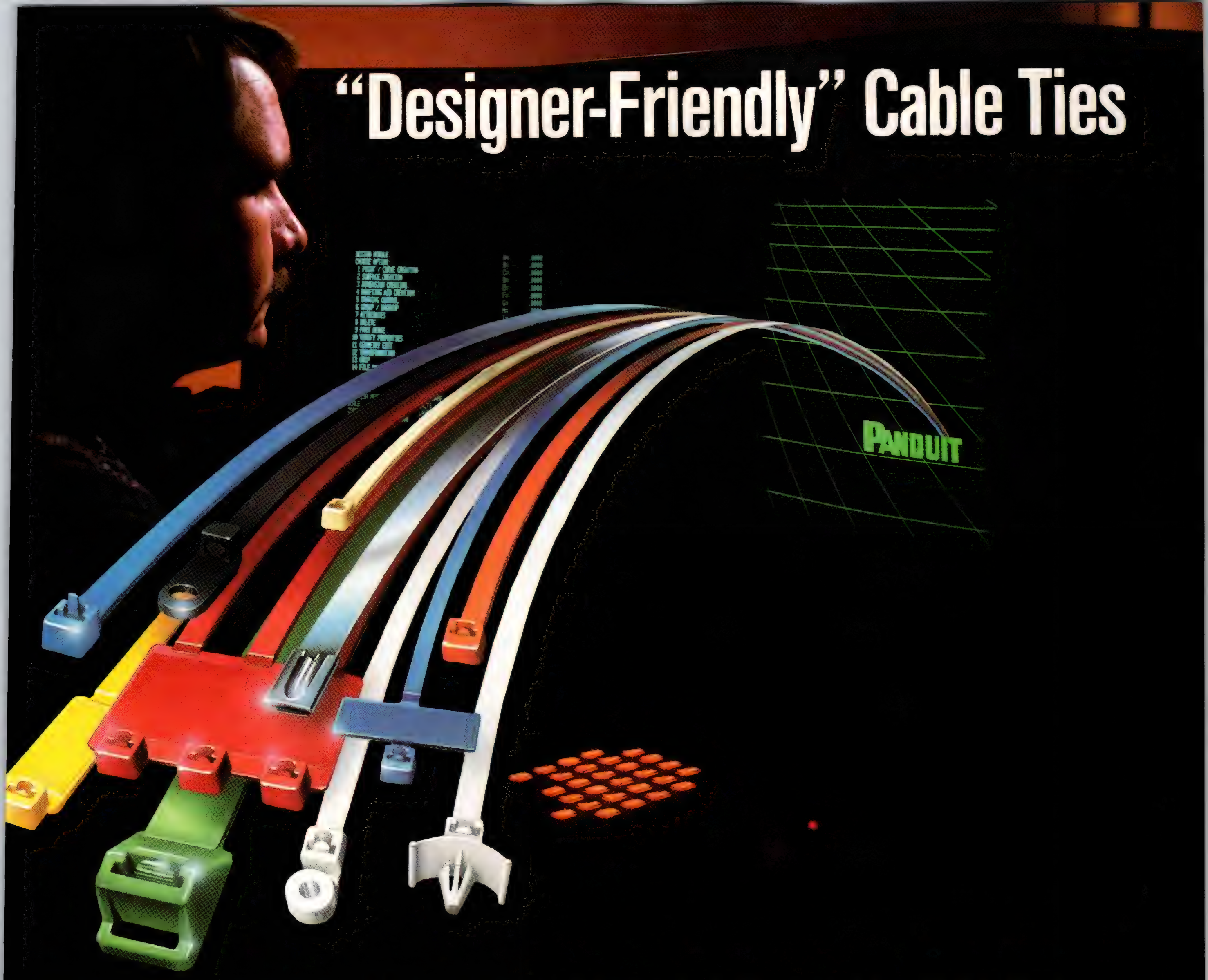
GENERAL SCANNING INC.

Charting the Path of Technology

500 Arsenal Street, Watertown, MA 02272
(617) 924-1010 Outside Mass. 800-343-1167

CIRCLE NO 233

“Designer-Friendly” Cable Ties



Five Reasons Why You Should Specify PANDUIT

1. Application Problems Solved
Choose from many materials (nylon, steel, fluoropolymers) to suit the application. Also available are mounts and accessories to complement these materials for your total package requirements. All have designed-in reliability for each environment.

2. Design Problems Solved
Specify from the widest selection of sizes, colors and styles that fit **your** design. Each is backed by more than 25 years of experience and approvals from U.L. and Mil. QPL.

3. Production Problems Solved
Select the installation tooling that meets your production needs: from hand or pneumatic powered through fully automatic—the only system that can install cable ties in less than a second. Each has design features to **lower your installed cost.**

4. Technical Problems Solved
Choose the company that provides the most experienced team in the industry, to back you all the way; from mag tapes for your CAD-CAE system (to speed specifications) to toll-free phone support before and after the sale.

5. Procurement Problems Solved
Specify the quality cable tie line and you'll get **much more**—service, delivery and support, all at competitive prices.

For FREE SAMPLES
and Further Information Call Today
1 (800) 777-3300
[In Chicago (312) 532-1800]

CIRCLE NO 234

PANDUIT CORP
ELECTRICAL GROUP
Tinley Park, IL 60477-0981
In Canada: Panduit (Canada) Limited

Visit PANDUIT at ELECTRO '88 Booths 342-343

applications. Staggered clip contacts are located on 0.1-in. centers. Standard 0.025-in.-square contact pins accept single-row female socket connectors or wire-wrap connectors that can interface with test equipment. From $23.98 for a 28-pin clip; from $30.95 for a 44-pin clip.

3M, Electronic Products Div, Box 540, Mentor, OH 44060. Phone (800) 321-9668; in OH, (216) 354-2101.

Circle No 405

TRANSFORMERS

- *Phase shift equals 1° max*
- *Occupy <0.5-in^3*

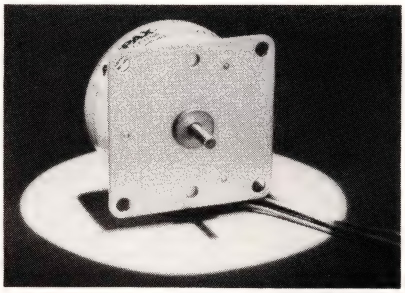
The Series 1800 isolation transformers provide high isolation with phase shifts of as little as 1° max. The units are designed to precede the input stages of hybrid synchro- or resolver-to-digital devices. Two of the units can also work with digital-to-synchro converters. The transformers occupy less than 0.5 in^3 and weigh only 0.75 oz. The family includes seven members with designations ranging from SIT/RIT1800 to SIT/RIT1840, and from RT1850 to RT1860. The SIT/RIT series and the RT1850 model are designed for frequencies from 360 to 440 Hz; the RT1860 accommodates frequencies of 47 to 440 Hz. $65 to $150. Delivery, six to eight weeks ARO.

Natel Engineering Co Inc, 4550 Runway St, Simi Valley, CA 93063. Phone (805) 581-3950. TWX 910-494-1959.

Circle No 406

STEPPER MOTORS

- *±0.5° tolerance*
- *Available in unipolar or bipolar versions*

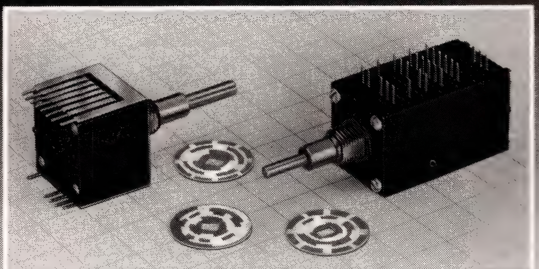


The Series L82400 permanent-magnet (PM) 42-mm stepper motors are designed to satisfy worldwide safety requirements. The holding torque specification for the PM motors ranges to 12.4 oz-in. and the step angle is 7.5°—48 steps per revolution. Noncumulative step-angle tolerance equals ±0.5°. The motors feature permanently lubricated bronze sleeve bearings. Versions are available for unipolar or bipolar operation from supply voltages of 5 or 12V dc. $7.65 (500) for bipolar version. Delivery, 4 to 12 weeks ARO.

Airpax Co, W Johnson Ave, Cheshire, CT 06410. Phone (203) 272-0301.

Circle No 407

MM P/REL™
Encoded Rotary Switch



The leader in digital rotary switching now brings you:
- Just .865″ square
- Enclosed, wave solderable construction
- Fixed or adjustable stops available
- 50,000 cycles
- Programmable to customer truth table

Call or write for applications assistance.

STANDARD GRIGSBY

920 Rathbone Avenue/P.O. Box 1528 • Aurora, Illinois 60507 USA
312 844-4300 • TWX 910 232-3138

80C31/51
Microcontrollers
A wide range in record time

☑ A choice between 4, 8 or 16 Kbytes of ROM, with on-chip RAM from 128 to 256 bytes, all CMOS.

☑ Operating clock speeds range from zero up to 16 and even 18 MHz!

☑ The MHS "Quick ROM" service can have customized samples or production parts delivered to your doorstep in just two or three weeks.

☑ And for ROMless 80C31/C32 parts, delivery worldwide is virtually instantaneous.

With over 7 million units delivered to date, MHS is one of the world's leading – and fastest – microcontroller suppliers.

MHS

Ask for a quotation today:

MATRA DESIGN SEMICONDUCTOR
2895 Northwestern Parkway
SANTA CLARA, CA 95015,
USA.
Tel. 408-986 9000, Tx. 299656

MATRA HARRIS SEMICONDUCTEURS
BP 309
78054 SAINT-QUENTIN-YVELINES CEDEX
FRANCE.
Tel. 1-30 60 70 00, Tx. 697 317

ELIMINATING FIRE RISK WITH PAPER!

Metallized plastic film capacitors
Rifa metallized paper capacitors
RIFA
PME 271 M
40/085/56
CV3

Without a capacitor, the power supplies or household appliances that you manufacture could cause radio frequency interference. With an unsafe capacitor, they could catch fire.

On average, such a cap has to take more than ten transient attacks a day. Consequently, the self-healing ability is decisive for a long life. But as the number of self-healings increases, so does the risk of breakdowns and short-circuits.

The ability to withstand high voltage transients is measured by a test called First self-healing. This is defined as a voltage drop of 5 V, and is executed periodically at the Rifa Laboratories in Kalmar, Sweden. For years, the outcome of this test has always been the same: 95% of metallized plastic film caps start self-healing at voltages lower than 3 kV; of metallized paper caps made by Rifa, less than five percent.

This test is regarded as a realistic way to quantify the risk of short-circuits. To that, add another aspect. The type of damage that can occur in a plastic cap, resulting in the winding melting or glowing, is a far greater fire hazard than a similar occurrence would be in a paper type cap.

QUALITY IN OUR BOOK

In our book, QUALITY means meeting your customer's performance requirements, and he certainly doesn't expect your product to catch fire or cause interference with radio frequencies, does he?

Rifa capacitors are made to meet the needs of practical applications, not just to come up to a standard.

So if you want all your products to perform faultlessly in any country, which capacitor do you choose?

To start with, send for our free brochure "Why Meeting Standards is Not Enough".

Please send the coupon to: RIFA AB
Box 945, S-391 29 Kalmar, Sweden

Please, send me my copy of your new brochure "Why meeting standards is not enough".

Name ________________

Company ________________

Address ________________

____

Country ________________

EDN 042888

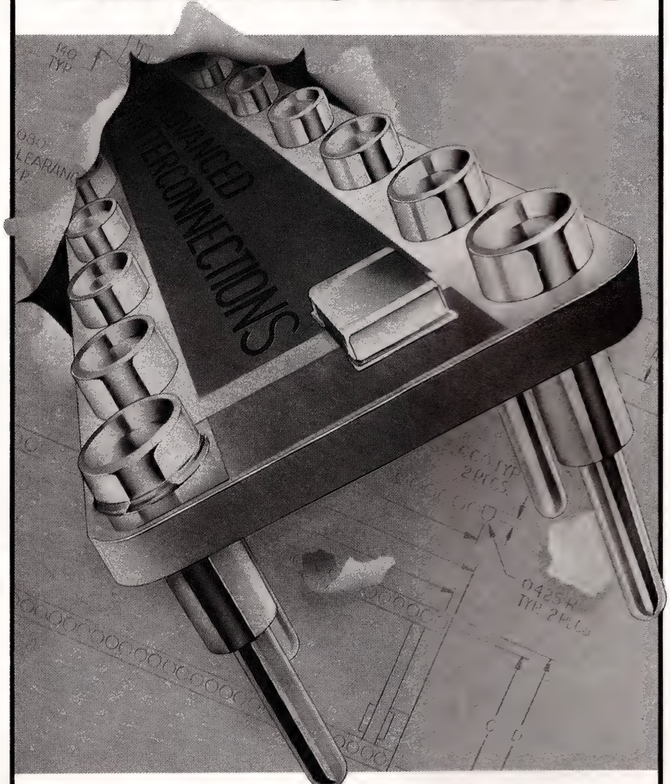
When your quality reputation depends on quality capacitors.

RIFA
capacitors

USA: RIFA Inc
403 International Parkway, Suite 501
RICHARDSON, TEXAS 75081
Tel +1 214 480 8300 • Telefax 1 214 680 1059

CIRCLE NO 72

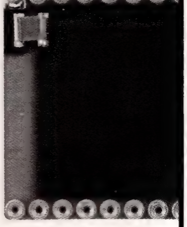
ADVANCED:
WHERE RESEARCH
BECOMES REALITY



Advance your Socket Technology with Surface Mounted Decoupling Capacitor Sockets

Advanced Interconnections has broken the noise barrier by Surface Mounting a Chip Capacitor as close as possible to the voltage pin on the socket body, to minimize induced noise.

- Standard Decoupling Capacitor values of .1 and .01 mf
- Copper Clad FR-4 solder-plated PC Board material
- Available in positions from 8 through 64 pin
- Available in mounted heights above PCB of .165", .120", .095" and two or three-level Wire-Wrap®
- Screw Machine hi-rel terminals with four-finger contacts
- Tapered entry for ease of insertion
- Closed end construction for 100% anti-solder wicking
- For non-standard applications consult factory.



ADVANCED
INTERCONNECTIONS

5 Energy Way, Dept. G., West Warwick, Rhode Island 02893
Tel. 401-823-5200 • FAX 401-823-8723 • TWX 910 2403454

Wire-Wrap® is a registered trademark of Gardner-Denver Co.

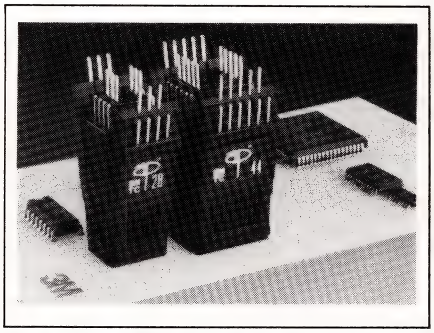
See us at ELECTRO, Booths 713 & 715

CIRCLE NO 38

the same range is 2 ppm/°C max. To operate, the oscillator needs only two external frequency-setting components. Its output frequency is programmable over the range from 0.4 to 10 kHz. Stability equals 10 ppm over 1000 hours; total harmonic distortion is 0.5% at 3300 Hz. To eliminate errors due to ground drops, two separate ground pins provide accurate ground sensing. The oscillator is available in either a 14-pin DIP or a flat pack. It's screened to MIL-STD-883C requirements. DIP versions, $86 to $112.20 (100); flat-pack models, $98 to $126.09.

Thaler Corp, 10940 N Stallard Pl, Tucson, AZ 85737. Phone (602) 742-5572. TLX 825193.

Circle No 404



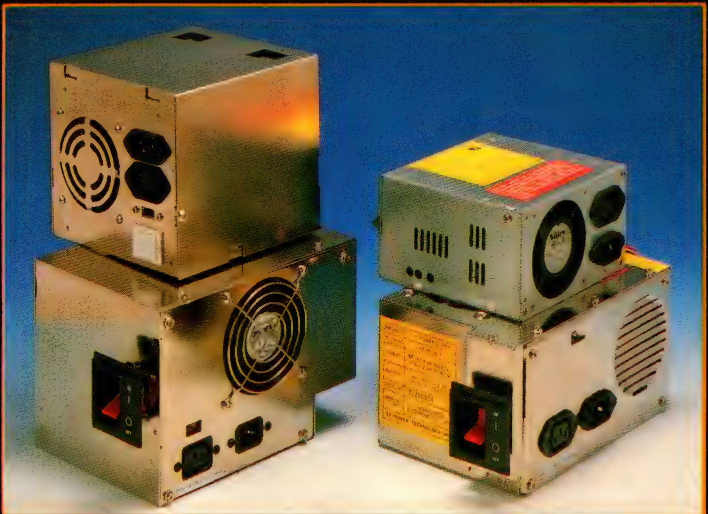
PLCC TEST CLIPS

- *Feature heavy-duty springs for positive contact pressure*
- *Narrow body design accommodates high-density applications*

The vendor's plastic leaded-chip-carrier (PLCC) test clips are now available in 28- and 44-pin sizes. They have an action-wedge design that allows all four sides to open simultaneously, thus providing a 1-step secure attachment to the PLCC under test. The clips also feature helical compression springs that ensure positive contact pressure, an insulating contact comb to prevent accidental short circuits, and a patented wiping action to ensure contact integrity in testing. The clips' narrow body design accommodates high-density pc-board

Switch with Liton

20-1,000W-Meets FCC, UL, CSA, TUV and VDE standards



aiwan Liton Electronic Co., Ltd. roduces a greater range of igh-performance switching ower supplies than most any ther manufacturer anywhere: 0-1,000W. By customizing ost-saving standard models ith an alternative component r two, available SPS configurations run into the thousands. esign and production fully neets FCC class "B", UL, CSA UV and VDE standards. pplications include PCs and orkstations, telecommunications equipment, as well as A equipment like facsimile machines, copiers and printers. C models are electrically as well as physically IBM PC/AT, PC/XT compatible and are full-power rated and wired for hard-disk or tape drives, as well as other peripherals.

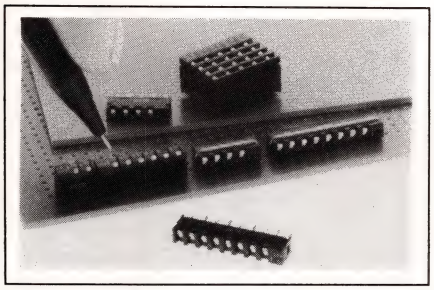
We've built our reputation with top-quality components. With gigantic facilities and modern equipment, we design and manufacture computer and communications products which meet the highest international quality control and performance standards.

Our R&D customizes a standard model or generates a 100% original design in a lead time worth switching for!

Taiwan Liton Electronic Co., Ltd.
12th Fl., 25 Tunhwa S. Rd., Taipei, Taiwan, ROC
Tel: (02) 771-4321/8 Fax: 886-2-751-1962 Tlx: 24514/20211 TWLITON

*IBM PC/AT and PC/XT are trademarks of the International Business Machines Corp.

CIRCLE NO 73



SWITCHES

- *SIP design saves board space*
- *Lifetime specs at 1000 cycles*

Designed in a single in-line package with a common bus, switches in the S Series take up about 50% of the board space utilized by a conventional DIP switch. The units are compatible with existing SIP insertion equipment and are available in two height configurations—0.295 and 0.177 in. Both versions are also available in right-angle configurations that measure only 0.16 in. high. The switches are available in 2-, 4-, 6-, 8-, and 10-position models. They feature high-pressure, gas-tight contacts and can accommodate wave soldering and aqueous or solvent cleaning processes. The switches have a rated lifetime of 1000 cycles. An 8-position model, $1.12 (10,000).

Augat Alcoswitch, 1551 Osgood St, North Andover, MA 01845. Phone (617) 685-4371.

Circle No 402

REED RELAYS

- *Contacts rated for 5W or 5 VA*
- *Designed to withstand SMA processes*

The materials and molded construction for the JS1 Series can withstand surface-mount assembly processes. The relays feature gull-wing style terminals and measure 0.235×0.22×0.55 in. The 1 Form A (spst NO) reed switch is rated for a maximum of 5W or 5 VA. Maximum switching voltage is 100V ac or dc, and maximum switching current specs at 0.5A. Initial dielectric strength equals 250V dc min between open contacts and 1000V dc between coil and contacts. The standard coil voltages are 5, 12, 15, and 24V dc. Nominal coil power dissipation ranges from 66 to 288 mW, depending on model. $4.26 (500). Delivery, stock to 10 weeks ARO.

Potter & Brumfield Inc, 200 S Richland Creek Dr, Princeton, IN 47671. Phone (812) 386-2276.

Circle No 403

OSCILLATOR

- *±0.02% initial accuracy*
- *2-ppm/°C drift (full MIL temperature range)*

The SWR200's 7.07V rms output has an initial accuracy of ±0.02% max over the full military temperature range. Temperature drift over

the low profile answer to the high power question . . .

The next time you ask yourself how to get all that power into such a small space, think of Intronics.

Introducing our new 100 Watt triple output, low profile DC/DC converter.

The KZ 400 Series does the job of three single output converters in a much smaller area—saving you valuable board space. It costs significantly less than individual converters and saves time and money on installation and inspection.

Designed primarily for the telecommunications, computer and instrumentation markets, the KZ 400 is metal encased with six-sided shielding and comes with a number of standard features. With 20 standard single and triple output models to choose from, it boasts a wide input range of 20-60 VDC and 36-72 VDC.

The KZ 400 delivers an impressive 80% typical efficiency and has a fixed switching frequency of 200 KHz. Line/load regulation specifications are ± 1% main channel and ± 5% auxiliaries. The unit is available in PC board and side mount models.

Get all the power you need at a lower cost—while increasing valuable board space. And at Intronics, you also get dependable service and product support. Call Intronics today at (617) 964-4000 about the new 100 Watt KZ 400 triple output DC/DC converter—the answer to your high power needs.

intronics

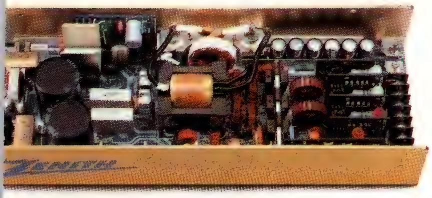
A Powerful Profile...

57 Chapel Street, Newton, MA 02158
617-964-4000 TWX 710-335-6835
TELEX 200095 INTL UR
FAX 617-527-3310

CIRCLE NO 37

SOMETIMES A MAJOR PLAYER CAN CHANGE THE WHOLE GAME.

INTRODUCING ZENITH'S NEW STANDARD SWITCHING POWER SUPPLIES.



Now that Zenith's stepped into the batter's box, standard power supplies will never be the same. Because we've taken our expertise from years in the "custom" business, and designed a full-featured product . . . at a standard price. And that means significant cost savings for you!

Starting this January, Zenith will offer a complete family of medium power, off-the-shelf, switching power supplies. And our new power supplies have got all the bases covered . . .

- Safety. The new series meets international safety requirements of UL 478; CSA 22.2, No. 154; IEC 380; VDE 0806; VDE 0871/B; FCC PART J, CLASS B.
- Flexible. All outputs are independently isolated, mag amp regulated, and adjustable. Outputs 2 and 3 can be widely adjusted between 10 and 15.5V to meet different equipment demands – at no extra cost!
- Tough. Exceeds 100,000 hours MTBF for durable performance.
- Reliable. Comes with 2-year warranty, fully backed by Zenith.

Output & Voltage Current Ratings

Model	Max Output Power (Watts)	Main Output		2nd Output		3rd Output		4th Output		Size (Inches)
		Volts DC (Min/Max)	Amps (Min/Max)	Volts DC (Min/Max)	Amps (Min/Max)	Volts DC (Min/Max)	Amps (Min/Max)	Volts DC (Min/Max)	Amps (Min/Max)	
ZPS-250-N	250	4.75/5.25	3.5/35.0	10.0/15.5	0.4/4.0 PK6	10.0/15.5	0.4/4.0 PK6	4.75/5.25	0.3/3.0	5.0 x 2.5 x 13
ZPS-300-N	300	4.75/5.25	4.5/45.0	10.0/15.5	0.8/8.0 PK12	10.0/15.5	0.8/8.0 PK12	4.75/5.25	0.4/4.0	5.0 x 2.5 x 13
ZPS-400-N	400	4.75/5.25	5.5/55.0	10.0/15.5	1.0/10.0 PK15	10.0/15.5	1.0/10.0 PK15	4.75/5.25	0.6/6.0	6.0 x 2.5 x 13

For optional steel cover substitute -C for -N in model number.

For more information, call

1-312-391-8700.

Because our new standards are going to be a big hit!

**SEE US IN ZENITH BOOTH 500-502
AT THE WESCON TRADE SHOW,
NOVEMBER 17TH-19TH.**

ZENITH

THE QUALITY GOES IN BEFORE THE NAME GOES ON®

Visit us at ELECTRO '88, Booths 2433, 2435, 2437

CIRCLE NO 74

"1987 The Babe Ruth Estate and Babe Ruth Baseball under license authorization by Curtis Licensing, Indianapolis, Indiana"

Sales Offices

Peter D. Coley, V.P. / Associate Publisher / Advertising Sales Director 617 / 964-3030. **Boston:** John Bartlett, Christopher Platt 617 / 964-3730. **New York / New Jersey:** Dan Rowland 212 / 463-6419. **Stamford:** George Isbell 203 / 328-2580. **Philadelphia:** Steve Farkas 215 / 293-1212. **Chicago:** Clayton Ryder, Randolph D. King, Maris Listello 312 / 635-8800. **Denver:** John Huff, 303 / 388-4511. **Dallas:** Don Ward 214 / 644-3683. **Orange / Riverside / San Diego Counties:** Jim McErlean 714 / 851-9422. **Los Angeles:** Charles J. Stillman 213 / 826-5818. **San Jose:** Walt Patstone, Bill Klanke, Phil Branon, James W. Graham 408 / 243-8838. **Portland:** Pat Dakin, Walt Patstone 503 / 297-3382.

United Kingdom / Benelux: Jan Dawson, Tel: 01-6287030, Telex: 914911. **France / Italy / Spain:** Alasdair Melville. Tel: 01-6287030, Telex: 914911. **Scandinavia:** Stuart Smith, Tel: 01-6287030, Telex: 914911. **West Germany / Austria / Switzerland:** Wolfgang Richter, Tel: 49-7451-7828, Telex: (841) 765450. **Eastern Bloc:** Uwe Kretzschmar, Tel: 01-6287030, Telex: 914911. **Israel:** Igal Elan, Tel: 972-3-252967, 268020, Telex: (922) 341667. **Asia:** Ed Schrader, General Manager, Tel: 714 / 851-9422. **Taiwan:** Parson Lee, Tel: 88-6-760-6209, Telex: 29809 HORTEX. **Japan:** Kaoru Hara, Tel: (03) 366-8301, Telex: J2322609 DYNACO. **Korea:** B.K. International, Tel: 785-6665, Telex: K32487 BIZKOR.

Info Cards: Lauren Fox 203 / 328-2580. **Product Mart:** Joanne Dorian 212 / 463-6 **Recruitment:** Roberta Renard, National Sales Manager 201 / 228-8602; Janet O. Penn, East Coast Manager 201 / 228-861 **Reprint Orders:** Ernie Kummer 312 / 635-8800. **Direct Mail Services:** Sid Black 312 / 635-8800.

EDN

Where advertising works

CAHNERS PUBLISHING COMPANY
A Division of Reed Publishing USA

Specialized Business Magazines for
Building & Construction, Manufacturing, Foodservice & Lodging,
Electronics & Computers, Interior Design, Printing, Publishing,
Industrial Research & Technology, Health Care, and Entertainment.
Specialized Consumer Magazines: American Baby and Modern Bride.

- COMPANY: Kepco, Inc.
- AGENCY: Zam, Kirshner, and Geller

- *"I was looking for power supplies. Fold-out ad did it."*
  Software Manager, Teledyne Systems Co.

- *"I like the detachable ad. I can remove for future reference."*
  Senior Field Test Engineer, Bendix Oceanics Division

- *"Very well laid out with a wealth of information."*
  Engineer, Delco Systems Operations

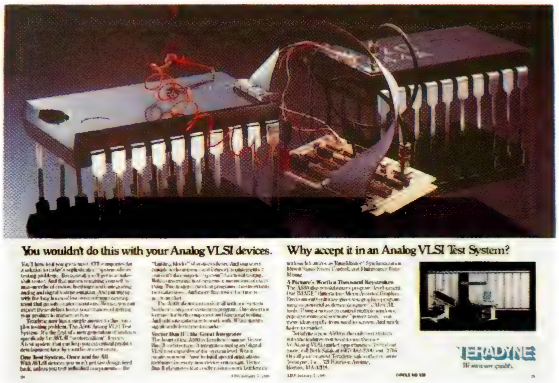
NEW KEPCO TDK INDUSTRIAL GRADE 150KHz FET-BASED SWITCHING POWER SUPPLIES SERIES RAX

- COMPANY: Teradyne Industrial Consumer Division
- AGENCY: Ingalls, Quinn & Johnson

- *"Very clever ad."*
  Design Engineer, Hewlett-Packard

- *"Excellent close-up photography and just enought text."*
  Member Technical Staff, Rockwell International

- *"Good graphics, good text. I can relate to the problem the product addresses."*
  Chief Engineer, EDI Inc.



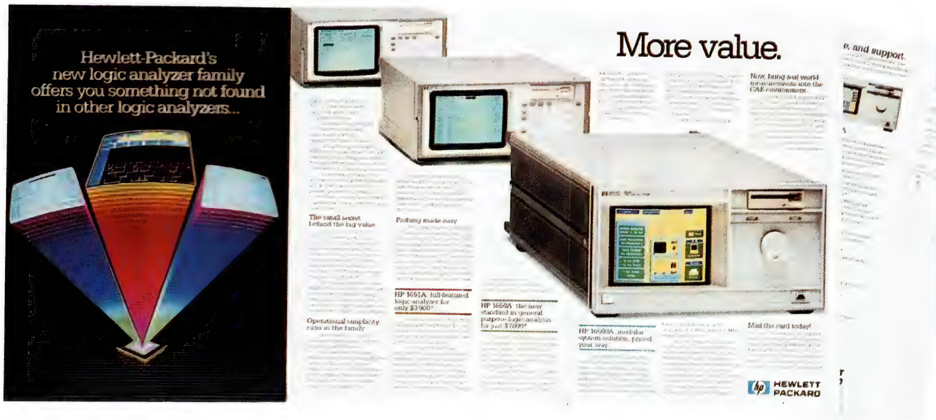
You wouldn't do this with your Analog VLSI devices.

Why accept it in an Analog VLSI Test System?

SECOND

- COMPANY: Hewlett-Packard CSD
- AGENCY: Tallant / Yates Advertising, Inc.

- *"Good graphics. Includes prices and convenient postcard."*
  Principal Engineer, Boeing Aerospace
- *"Excellent use of vivid colors."*
  Member Engineering Staff, RCA
- *"Technically informative, with prices."*
  Design Engineer, Digitech Industries Inc.



Hewlett-Packard's new logic analyzer family offers you something not found in other logic analyzers...

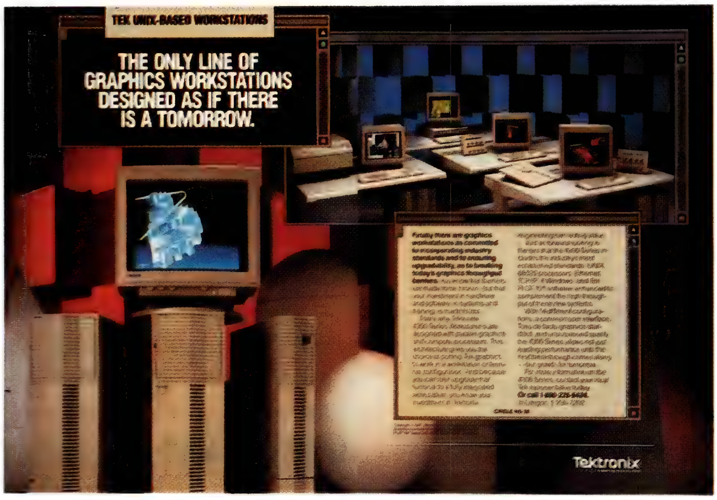
More value.

HEWLETT PACKARD

THIRD

- COMPANY: Tektronix, Inc.
- AGENCY: Young & Roehr

- *"Stands out. States unique features."*
  Project Engineer, Delco Electronics
- *"Clever and informative."*
  Project Engineer, Hughes Aircraft
- *"Graphically interesting ad."*
  Electronic Design Engineer, Antares Group, Inc.

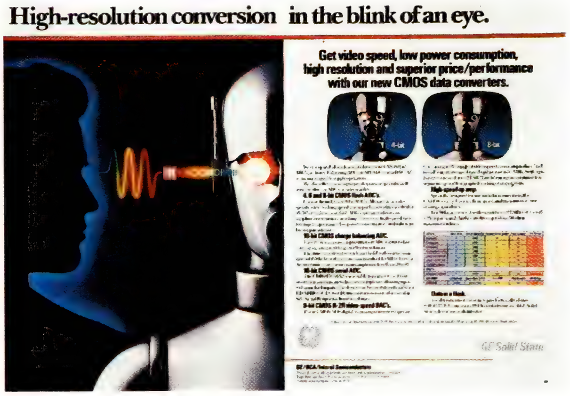


TEK UNIX-BASED WORKSTATIONS

THE ONLY LINE OF GRAPHICS WORKSTATIONS DESIGNED AS IF THERE IS A TOMORROW.

- COMPANY: GE Solid State
- AGENCY: Cappiello & Chabrowe

- *"Impressive 4-bit vs. 8-bit comparison."*
  Engineer, Martin Marietta Electronic Systems
- *"Eyecatching and informative."*
  Engineer, Motorola Inc.
- *"The robot makes you look twice."*
  Senior Engineer, Medtronic, Inc.

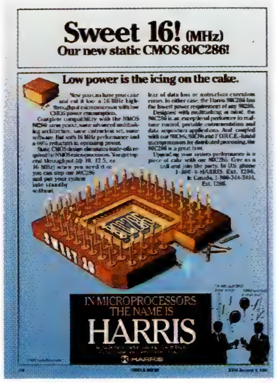


High-resolution conversion in the blink of an eye.

Get video speed, low power consumption, high resolution and superior price/performance with our new CMOS data converters.

- COMPANY: Harris Semiconductor
- AGENCY: The Downs Group, Inc.

- *"Photo is an attention getter."*
  Engineer, EG&G Energy Measurements
- *"This one takes the cake! Neat idea."*
  Engineer, IBM Corp.
- *"The party image makes you want to join in."*
  Design Engineer, Utica Systems



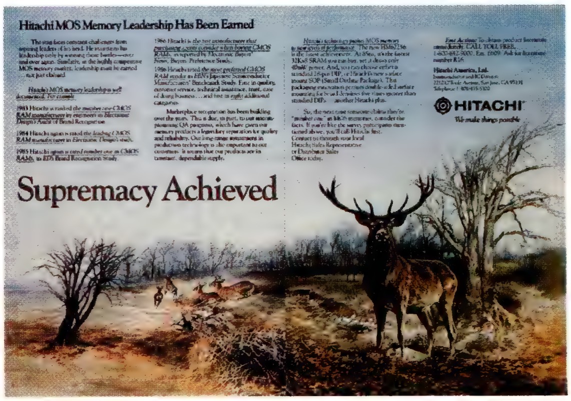
Sweet 16! (MHz)
Our new static CMOS 80C286!

Low power is the icing on the cake.

IN MICROPROCESSORS THE NAME IS HARRIS

- COMPANY: Hitachi America, Ltd.
  Semiconductor and IC Division
- AGENCY: Sutter / Martin

- *"Refreshing to look at—informative."*
  Engineer, King Radio Corp.
- *"The painting in this ad is a truly artistic work."*
  Design Engineer, Infocom
- *"Picture complements the ad text."*
  Senior Mechanical Designer, Trebor Inc.



Hitachi MOS Memory Leadership Has Been Earned

Supremacy Achieved

HITACHI
We make things possible

- COMPANY: 3M Industrial Chemical Products Division
- AGENCY: Kerker & Associates, Inc.

- *"A very colorful, sophisticated, yet simple ad."*
  Electronic Engineer, UPA Technology
- *"Interesting design. Full of information*
  Aerospace Engineer, NASA
- *"Full page graphics draw attention to informative product specs."*
  Engineer, National Security Agency

- COMPANY: AT&T Microelectronics
- AGENCY: FCB / Leber Katz Partners

What do you need to build on a rough application concept?
AT&T. The components of success.
CHIMNEY
SKYLIGHTS
WATER
AT&T
The right choice

- *"Allows imagination to prompt reading of entire ad."*
  Engineer, General Electric
- *"Nice concept. The house is a dream."*
  Component Test Engineer, NCR
- *"Dedicated to every engineer who has scribbled on a napkin!"*
  Project Manager, IRT Corp.

- COMPANY: Dupont Electronics
- AGENCY: Ketchum Advertising

- *"Picture caught my eye."*
  Design Engineer, Hewlett-Packard
- *"Impressive close-up."*
  Software Engineer, Unisys
- *"Sharp photograph. Good packaging."*
  Chief Scientist, U.S. Army

- **COMPANY: Inmos**
- **AGENCY: Thomas & Perkins**

- *"Football player draws interest. Text ties in well with picture."*
  Chief Engineer, Beckman Instrument
- *"Eyecatching color graphics. Table gives lots of info quickly."*
  Engineer, Litton Electron Devices
- *"Seasonal picture, good layout, concise details."*
  Member Technical Staff, Advanced Micro Devices

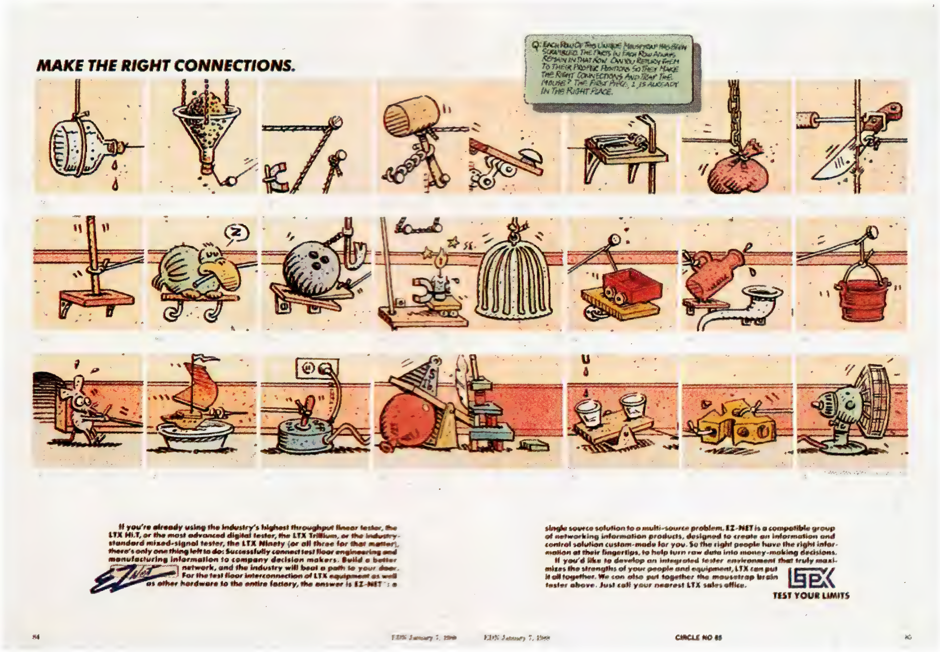
- **COMPANY: IOtech**
- **AGENCY: In-house**

IEEE 488 Software Selection Guide
Application Specific Environments
Digital I/O
IOtech
IEEE 488 Solutions.

- *"Describes the products very well."*
  Engineering Manager, International Rectifier
- *"Contains useful information, including prices."*
  Senior Engineer, Johnson Controls Inc.
- *"Great use of color."*
  Engineer, Wilding Electronics

FIRST

- **COMPANY: LTX**
- **AGENCY: Kelley & Wallwork**



Q: EACH ROW OF THIS UNIQUE MOUSETRAP HAS BEEN SCRAMBLED. THE PARTS IN EACH ROW ALWAYS REMAIN IN THAT ROW. CAN YOU RETURN THEM TO THEIR PROPER POSITIONS SO THEY MAKE THE RIGHT CONNECTIONS AND TRAP THE MOUSE? THE FIRST PIECE, 1, IS ALREADY IN THE RIGHT PLACE.

If you're already using the industry's highest throughput linear tester, the LTX Hi.T, or the most advanced digital tester, the LTX Trillium, or the industry-standard mixed-signal tester, the LTX Ninety (or all three for that matter), there's only one thing left to do: Successfully connect test floor engineering and manufacturing information to company decision makers. Build a better network, and the industry will beat a path to your door. For the test floor interconnection of LTX equipment as well as other hardware to the entire factory, the answer is EZ-NET™: a single source solution to a multi-source problem. EZ-NET is a compatible group of networking information products, designed to create an information and control solution custom-made for you. So the right people have the right information at their fingertips, to help turn raw data into money-making decisions.

If you'd like to develop an integrated tester environment that truly maximizes the strengths of your people and equipment, LTX can put it all together. We can also put together the mousetrap brain teaser above. Just call your nearest LTX sales office.

CIRCLE NO 85

- *"This ad made every engineer I know stop and take notice."*
  Electronic Engineer, Texas Instruments

- *"Rube Goldberg puzzle got my attention."*
  Electrical Engineer, Naval Air Test Center

- *"I spent a lot more than 30 minutes on these two pages."*
  Diagnostic Engineer, Olivetti A.T.C.

PRESENTING THE WINNING ADVERTISERS

From the EDN January 7, 1988 Issue

Here are the winning advertisements from EDN's January 7, 1988 Reader Vote Contest. Our readers analyzed and evaluated the advertisements in the issue to select the ones they judged to be the most informative, helpful and attractive. Congratulations to the advertisers and agencies who combined well-written copy and superior design to create these winning advertisements. A special thank you to the readers who took the time to participate. Here then are the outstanding performers . . .

terruptible power supply is small enough to fit under most desktop computers or word processors. In the event of a line-input failure, or a drop in the line voltage of 15% or more, the unit automatically switches over to its integral-battery backup power. The integral batteries can provide as much as 15 minutes of backup power to connected equipment. An audible and visual alarm indicates that the line supply has failed, and a second audible alarm indicates that only one more minute of battery backup is left. The output power is rated at 300 VA, and the unit operates from 220/240V 50-Hz line-input supplies. The unit also includes line-input filtering to protect connected equipment against noise, interference, voltage spikes, or voltage surges that appear on the line supply. It has two 220/240V 50-Hz output connectors supplied from the uninterruptible supply, and one output socket that is supplied from the filtered line input. £300.

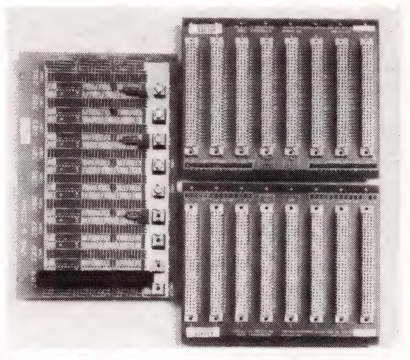
Dowty Power Conversion Ltd, Brunel Rd, Salisbury, Wiltshire SP2 7PT, UK. Phone (0722) 28801. TLX 477064.

Circle No 400

BACKPLANES

- *Designed for VME Bus applications*
- *5- to 20-slot versions available*

The VMEJ Series of backplanes is available in a variety of sizes and configurations to meet almost any VME Bus application. Both the VMEJ1 and VMEJ2 models come with anywhere from 5 to 20 slots. You can order the VMEJ1 with anywhere from 6 to 21 power terminals; the VMEJ2 line, from 4 to 10 power terminals. All versions have a multilayer backplane design that conforms to the most recent VME Bus specifications, jumper positions for daisy-chaining Bus Grant and IJack signals, 20A power terminals, and 32-bit expansion and user I/O. The backplane design also lets you use a plug-in VMX board that connects to I/O-bus rows A and C on the connector. A 5-slot VMEJ1 backplane, $195.



Stanford Applied Engineering, 3520 De La Cruz Blvd, Santa Clara, CA 95050. Phone (408) 988-0700. TWX 910-338-0132.

Circle No 401

Continued on pg 288

FAST DC/DC
TRANSIENT RESPONSE
CONVERTERS
•Current Mode Controlled
•Excellent Line Regulation
•Wide Input Range
•High MTBF
FAST DELIVERY

WATTS	SERIES
5	GW
15	NW
30	QW
40	LK
60	RW
120	UW

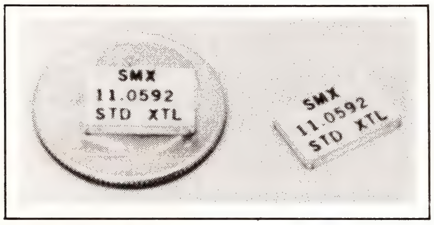
95 MODELS FROM
IPD
INTERNATIONAL POWER DEVICES, INC.
155 N. BEACON ST., BRIGHTON, MA 02135
Phone: (617)782-3331 * Fax: (617)782-7416 * Telex: 989-752
CIRCLE NO 35
See us at ELECTRO, Booth 2724

V SERIES
SWITCHING POWER SUPPLIES
Engineered and Manufactured by Perfectionists!
Simulations by SPICE
Stability by HP/VENABLE
Sheet Metal by AMADA
Auto Insert by UNIVERSAL
Testing by ZEHNTEL
Burn In by CENTIGRADE
Service by PHILLIPS
Call Toll Free 1-800-523-2332
Deltron inc.
P.O. BOX 1369 ■ WISSAHICKON AVENUE, NORTH WALES, PA 19454
PHONE 215/699-9261 TWX 510/661-8061
See us at ELECTRO/'88, Booths 406-408
CIRCLE NO 36

the IEEE-802 standard for LAN interfaces, these tin-plated, metal-shell plug and receptacle connectors have a lifetime spec of 500 mating/unmating cycles. The plug shells feature grounding indents for EMI/RFI compatibility. Slide-latch version, $2.30; locking-post model, $1.44 (1000). Delivery, stock to six weeks ARO.

AMP Inc, Box 3608, Harrisburg, PA 17105. Phone (717) 564-0100.

Circle No 398



CRYSTALS

- *Operate from −55 to +150°C*
- *Compatible with automatic assembly equipment*

Devices in the SMX Series of ceramic surface-mount AT quartz crystals measure 0.07×0.4×0.25 in. They are available with frequencies between 5 and 160 MHz. The standard operating range is −55 to +150°C; typical drive level is 150 μW. Crystals with room-temperature tolerances of 0.001, 0.005, or 0.01% are available. The basic construction features soldering pads that make the units compatible with automatic assembly equipment. $4.80 to $9 (1000). Delivery, 10 to 12 weeks ARO.

Standard Crystal Corp, 9940 E Baldwin Pl, El Monte, CA 91731. Phone (818) 443-2121.

Circle No 399

DESKTOP UPS

- *Protects desktop equipment from line failures*
- *Includes line-supply filtering and internal batteries*

Measuring 15.75×15.75×2.95 in. (400×400×75 mm), the DT300 unin-

Are you trying to put a PC where it doesn't belong?

Our STD BUS single board computer runs MS-DOS 3.3 and thrives as the embedded microcomputer inside your machine. And it needs no special handling in the rugged conditions of the factory floor.

Choose your disks—semiconductor, hard or floppy. Add the STD BUS analog & digital I/O and networking you need. Now you have an industrial strength computer that will go where the PC shouldn't. A two-year warranty is standard.

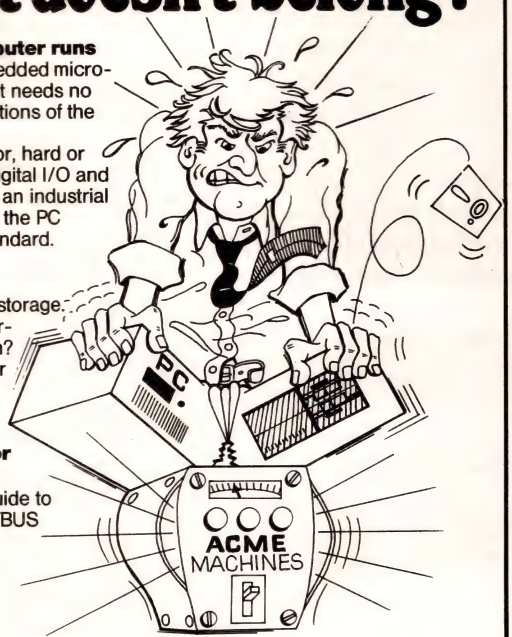
GONE DISKLESS LATELY?

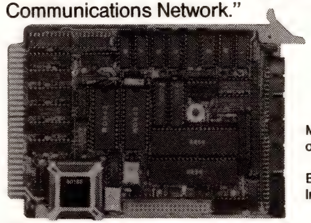
Many applications don't need disk storage. So why bother with disks, and the overhead and royalties that come with them?

Ask us about our software tools for the diskless MS-DOS environment.

To learn more, call and ask for our FREE "Application Guide for the CDI-DOS Spectrum."

MORE new application notes—"A Guide to Interfacing the STD BUS with the BITBUS Communications Network."





CPU-188 Single Board Computer runs MS-DOS.

MS-DOS is a trademark of Microsoft Corp.

BITBUS is a trademark of Intel Corp.

Computer DYNAMICS
COMPUTER DYNAMICS SALES
107 S. MAIN ST., GREER, SC 29651 (803) 877-8700

CIRCLE NO 33

...and we'll back it up!

750 WATT multiple output battery backup supply.

For safe and orderly system shutdown in the event of blackout or even brownout situations, choose our battery backup switching power system.

JETA's proven multiple output power supply technology combines with a dual-stage charger, boost converter and 48V battery to provide your system with unlimited holdup time (depending on battery capacity) in the event of AC line failure.

2-YEAR WARRANTY on all models

At JETA, we back up all our power supplies with a full two-year guarantee. After we beat them up and then burn them in, we're confident that you'll receive the finest high-current power supplies built.

For single and multiple output power supplies from 500 to 2200 watts, contact JETA. We back them up.

See EEM pages D1706-1708

JETA POWER SYSTEMS, INC.
2675 Junipero Avenue ■ Signal Hill, CA 90806
Tel: 213/427-0095 ■ TWX: 510-101-1804 ■ FAX: 2134262417

CIRCLE NO 34

Simpson® Professional Series ★ Quality and Reliability ★

MENU-DRIVEN MULTIMETER — MODEL 560

The newest addition to the ***PROFESSIONAL SERIES***, the MODEL **560**, incorporates measurement capabilities usually provided through the use of separate instruments. The **560** is a microprocessor based, 52,000 count, menu-driven multimeter designed and built with the requirements of the serious engineer in mind. The **560** provides the accuracy and stability necessary for exacting testing applications.

COMPUTER-AGE SOPHISTICATION IN A BENCH TOP DMM

Features
- Ultra Fast Autoranging
- Front Panel Programming
- Data Logging to 2150 Readings on any Selected Range
- 52 Segment Bar Graph
- 500kHz Frequency Counter
- Battery Backed Data Storage Buffer
- RS232C Capable
- Centronics Printer Capable
- REL and Continuity

MENU-DRIVEN MULTIMETER

• Model 560	**$2,195.00**
• Model 560 w/BUS Interface	**$2,395.00**

Made in USA

SIMPSON ELECTRIC COMPANY
853 Dundee Avenue, Elgin, Illinois 60120-3090
(312) 697-2260 • Telex 72-2416 • FAX (312) 697-2272

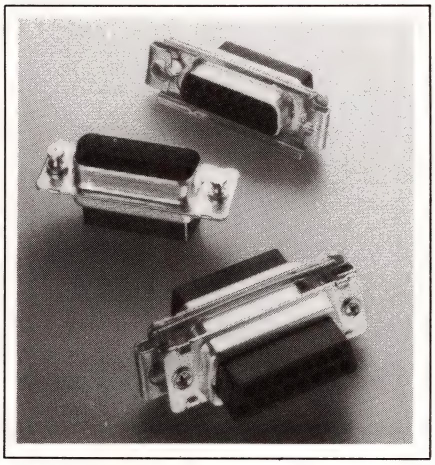
A CHIPPEWA NATION TRIBAL ENTERPRISE

CIRCLE NO 210

tal oscillators are TTL/CMOS compatible and TTL compatible, respectively. They are available with output frequencies in the 875-kHz to 28-MHz range. In addition, the oscillators have an operating-environment specification that meets or exceeds the requirements of MIL-0-55310/19—making them suitable for use in military and avionics equipment. All the oscillators are housed in a 40-pin ceramic-chip-carrier package, and they have an operating temperature range of −55 to +125°C. Over this operating temperature range, their frequency tolerance (relative to their nominal frequency) is ±100 ppm. For even more demanding applications, the oscillators will be available in a radiation-hard form, constructed from high-purity quartz crystal and SOS circuitry. Approximately £40 (100).

Salford Electrical Instruments Ltd, Times Mill, Heywood, Lancashire OL10 4NE, UK. Phone (0706) 67501. TLX 635106.

Circle No 397



CONNECTORS

- *Compatible with the IEEE-802 standard*
- *Grounding indents for EMI/RFI compatibility*

These Amplimite 15-position subminiature D connectors feature preassembled slide latches and locking posts that save valuable installation time and effort. Compatible with

DOING PART OF THE JOB
IS NOT ENOUGH
Integrated CADdy Does It All!

Schematic capture: Dynamic symbol call-up…automatic naming/numbering …rubberbanded connections …edge-of-sheet and bus symbols… expandable library.

Component data base: Defines/ manages data flow between schematic and PC Board. Automatic features—file naming, multi-sheet management, BOM, netlist, back-annotation, layer management, project archiving.

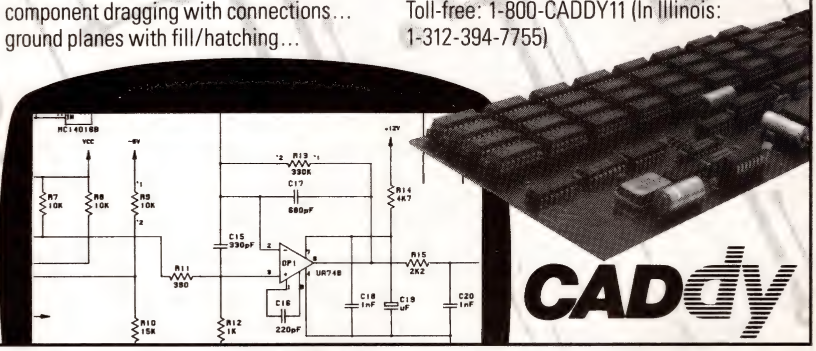
PCB Layout: Components dynamically positioned with rotate or mirror (for SMD)…auto-ratsnest…pin/gate/ component name swapping… component dragging with connections… ground planes with fill/hatching… user-defined pads, vias, trace width, automatic artwork generator…output to major pen plotters and Gerber… optional Excellon.

CADdy Autorouter: Options—Standard or High-performance.

Full-featured Drafting: Mechanical auto-dimensioning with tolerancing, construction aids, calculators…and more.

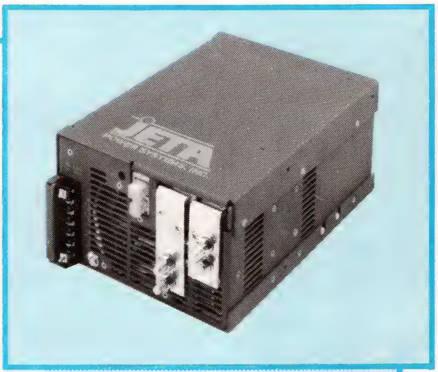
Polished **Technical Documentation**

For additional information call:
CADdy CORPORATION, 3 Crossroads of Commerce, Rolling Meadows, IL 60008
Toll-free: 1-800-CADDY11 (In Illinois: 1-312-394-7755)



See us at ELECTRO, Booth 2951.
CIRCLE NO 31

or…
1500 or
1800
WATTS
in the same box.



Whether you need 1500 or 1800 watts, JETA satisfies your power supply need with a single case size. So if your system requires higher power ratings in the future, you won't have to worry about fitting in a new power supply . . . saving you both time and money.

As with all JETA power supply designs, these units undergo our standard "beat-up" tests to assure continued performance under operating conditions that your system will probably never see—from powering-up into short circuit and no-load conditions to short circuiting the unit at full load—over and over again. Finally, they get a 24-hour burn-in.

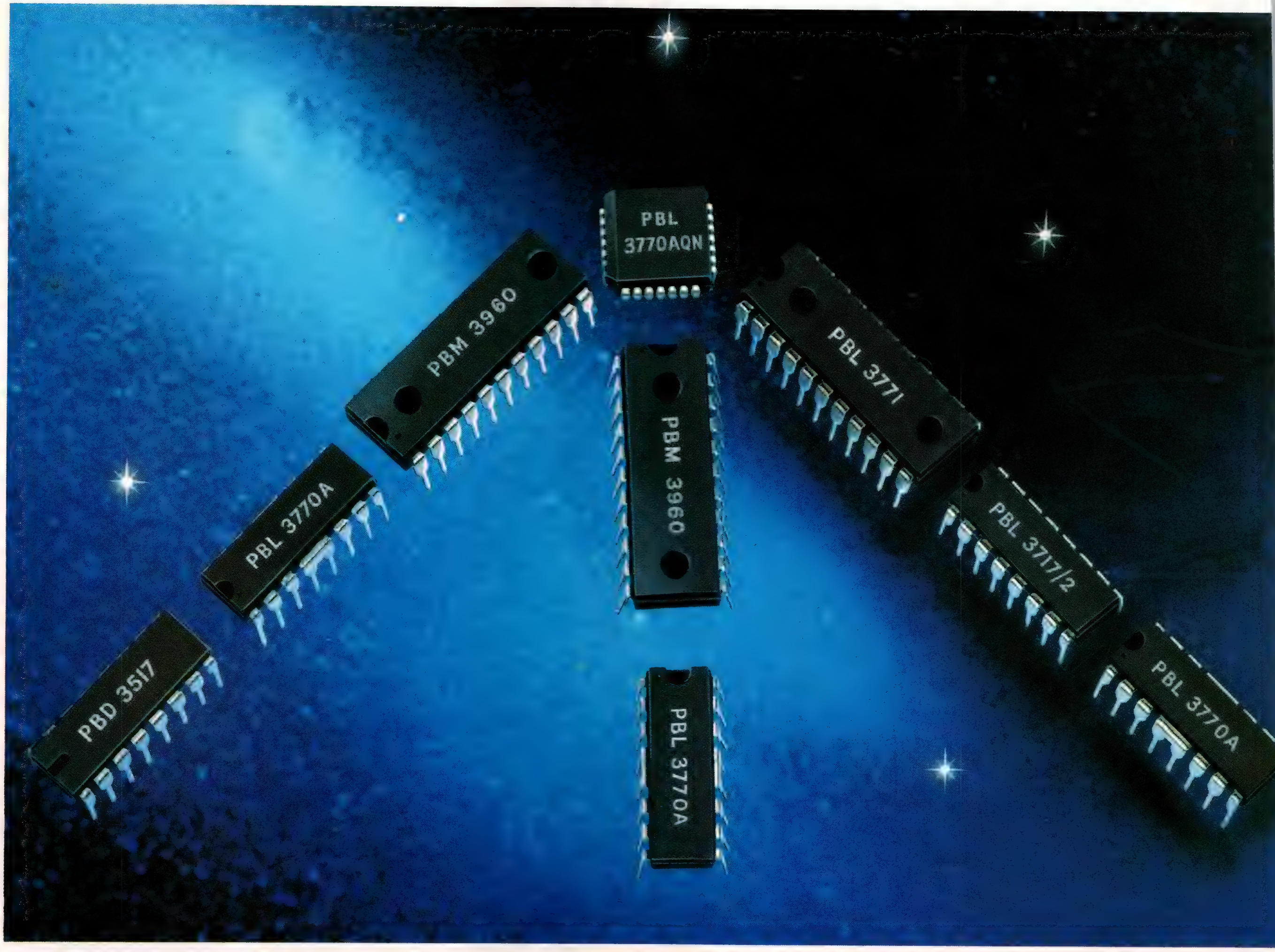
For cost-effective, performance proven, high-current single and multiple output power supplies from 500 to 2200 watts, contact JETA.

See EEM pages D1706-1708

JETA POWER SYSTEMS, INC.
2675 Junipero Avenue ■ Signal Hill, CA 90806
Tel: 213/427-0095 ■ TWX: 510-101-1804 ■ FAX: 2134262417

CIRCLE NO 32

Stepper Motor Drivers.



Choose Ericsson Components and discover how the world's leading family of motor control devices gives you more choice, more applications, more innovation and much more performance for your space and money.

PBL 3717/2.
Latest version of our industry-standard PBL 3717. Constant current switchmode control uprated to 1.0A continuous output current from previous 0.8A. High, medium, low (park) and true zero output; half- and micro-stepping capabilities; all with the utmost efficiency and performance. Widely copied – come to the source for the brightest and best.

PBL 3770A.
Our brilliant new star. 1.5A continuous, 1.8A peak current. Drives all kinds of motors. Low heat dissipation, high packing density. 16-pin DIP version is pin-compatible with 3717; also 28-pin PLCC version.

PBD 3517.
Low-cost driver for unipolar motors. Economical, reliable, complete – you only need one small driver per motor.

PBL 3771 + PBM 3960.
The new, sophisticated micro-stepping system. Dual precision chopper-driver with dual 7-bit-plus-sign D/A converter. Output 600mA per phase, automatic slow/fast current decay, plus very good low-current linearity – this is the universal leader in micro-stepping performance.

Note: All our stepper motor drivers (except PBD 3517) are available in DIP or PLCC packages. PBL 3717/2, 3770A, and 3771 all have a special lead-frame for heat-sinking through ground pins to the pc board copper.

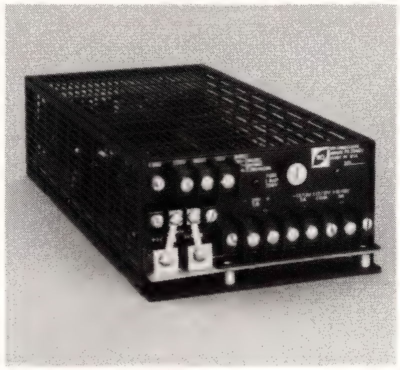
We're in the lead

ERICSSON

Ericsson Components AB
S-164 81 Kista—Stockholm, Sweden
Telephone +46 8 757 5000
Telefax +46 8 752 6034

Formerly known as RIFA

COMPONENTS & POWER SUPPLIES



POWER SUPPLY

- *One output dedicated to disk-drive needs*
- *Includes self-recovering OVP on all outputs*

The quad-output Model 524EU power supply employs a 50-kHz MOSFET design with independent magnetic amplifiers in the secondary windings. The supply outputs are 5V at 20A, 12V at 3A, −12V at 2A, and 24V at 2A (for disk drive applications). The secondary windings are adjustable to 15V at 2.5A and −15V at 1.5A. You can select input ranges of 105 to 130 or 198 to 265V ac. All outputs are current limited and have continuous overload, short-circuit, and overtemperature protection. Self-recovering overvoltage protection is provided on all outputs. The supply has no minimum load requirements and includes input protection that meets the IEEE-587 voltage transient test. Power-fail and logic-inhibit signals are available as options. From $395.

RO Associates Inc, 246 Caspian Dr, Sunnyvale, CA 94088. Phone (408) 744-1450. TWX 910-339-9304.

Circle No 396

OSCILLATORS

- *Suitable for use in military and avionics equipment*
- *Tolerance of ±100 ppm over operating temperature range*

The outputs of QC6111- and QC6112-Series surface-mount crys-

INTROL CORPORATION
647 W. Virginia St.
Milwaukee, WI 53204
Phone: 276-2937
Fax: 276-7026

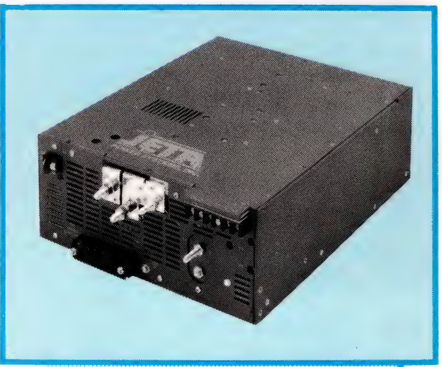
LIBRARIES
UTILITIES
DEBUGGERS
MACRO ASSEMBLERS
MODULA-2 COMPILERS
C COMPILERS

MAKE THE MOST EFFICIENT USE OF YOUR TARGET PROCESSORS' RESOURCES WITH INTROL CROSS DEVELOPMENT TOOLS.

■ TARGETS SUPPORTED:
6804 6805 6301/03 6801/03
6809 68HC11 68000/08/10/12
68020/30/881/851 32000/81/82
■ Available for the following hosts:
■ VAX ■ APOLLO ■ SUN
■ PC, XT, AT & COMPATIBLES
■ GOULD POWER NODE

CIRCLE NO 29

with 5 outputs...
to 2200 WATTS



Main output to 300A. Our 2200 watt, UL/CSA/VDE/IEC compliant, power supply offers 1 to 5 outputs. Standard features include DC OK, FCC EMI filter, power fail, remote inhibit, remote margining, electronic soft start and more—many of which would be costly options elsewhere.

High reliability is derived from a reduced component count, high-voltage transistor V-I load reshaping for maximum SOA and careful thermal management to ensure the best operating environment for critical components.

For reliable high-current single and multiple output power supplies from 500 to 2200 watts, contact JETA.

See EEM pages D1706-1708

JETA POWER SYSTEMS, INC.
2675 Junipero Avenue ■ Signal Hill, CA 90806
Tel: 213/427-0095 ■ TWX: 510-101-1804 ■ FAX: 2134262417

CIRCLE NO 30

WHEN BUYING SWITCHES REMEMBER THREE THINGS.

C&K Components, The Primary Source Worldwide,® celebrates its 30th anniversary by expanding your sources for switches.

For toggle, rocker, slide, DIP and thumbwheel switches, your source is the original C&K Components, Inc.

For switchlocks, rotary and slide switches, your source is C&K Clayton Division.

For snap-acting and metal-cased control switches, your source is the new C&K/Unimax.

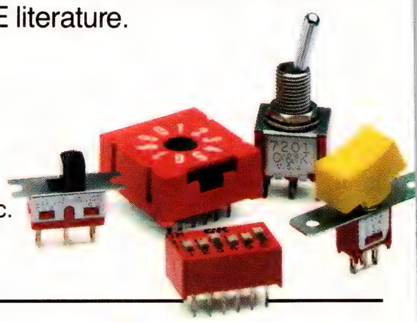
Whichever you choose, remember C&K gives you the broadest selection of switching configurations to meet a variety of changing needs plus quality, quantity, performance, delivery and low-cost.

Need proof? Just send us your specs and description of your application, we'll quickly send you a sample switch that fits your needs. Without charge or obligation.

Or, call for our FREE literature.

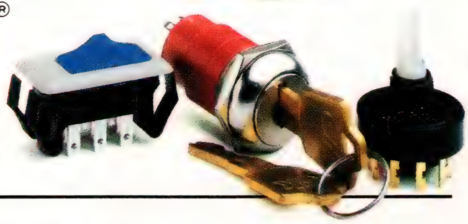
C&K®

C&K Components, Inc.
Newton, MA 02158
Tel. (617) 964-6400



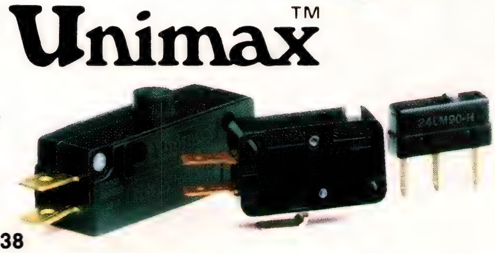
C&K®

C&K Clayton Div.
Clayton, NC 27520
Tel. (919) 553-3131



C&K / Unimax™

C&K/Unimax
Wallingford, CT 06492
Tel. (203) 269-8701



See us at ELECTRO, Booth #s 434-438

CIRCLE NO 212

The devices have breakdown voltages of 6.5 and 25V, respectively, and clamping voltages of 12 and 35V, respectively. At 5V, they have shunt capacitances of 500 and 300 pF, respectively. Their overload voltage rating is 25 kV. In addition to shunting the data bus with the protection diodes, the devices also provide protection against continuous short circuits on the lines. In the event of short circuits, the pin-to-die bonding wires within the package act as fusible links, which open circuit the line. TH6P04T6V5CL, $5.50; TH6P05T25CL, $5 (1000).

SGS-Thomson Microelectronics, Via C Olivetti 2, 20041 Agrate Brianza, Italy. Phone (039) 65551. TLX 330131.

Circle No 394

DC/DC CONVERTERS

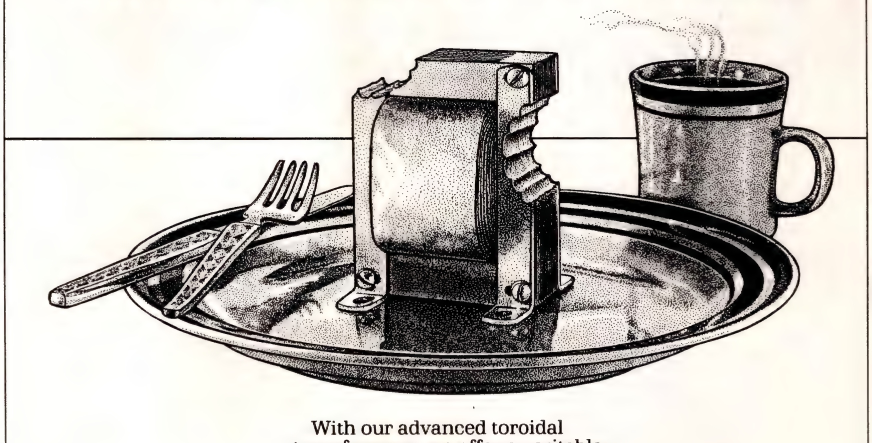
- *Provide a minimum efficiency of 80%*
- *Line and load regulations are 0.2%*

The XC Series dc/dc converters accept any input voltage between 24 and 72V dc and provide one of three outputs: 5V at 3A, 12V at 1.25A, or 15V at 1A. All three converters have an 80% (min) efficiency, even for 20% load levels. Key specifications include 0.2% for both line and load regulations, 30-mV output noise (p-p), 500V dc isolation, and −25 to +80°C operating range. Internal circuitry supplies 8 hours min short-circuit protection, and an internal thermal-limit circuit shuts a unit down when the case temperature exceeds the specified limit. The converters automatically restart when the temperature returns to normal. Filter circuits provide conducted-noise protection for both the input and the output. A 6-sided shielded case minimizes RFI problems. $120.

Calex Mfg Co Inc, 3355 Vincent Rd, Pleasant Hill, CA 94523. Phone (415) 932-3911. TLX 338506.

Circle No 395

We eat conventional transformers for breakfast



With our advanced toroidal transformers, we offer a veritable menu of benefits for your state-of-the-art electrical designs and applications.

Our TOREMA toroids are *lighter, quieter* and *smaller* than traditional laminated transformers *AND* other toroids, too... food for thought when you're looking for exceptional technical and design advantages as well as significant savings in your finished product.

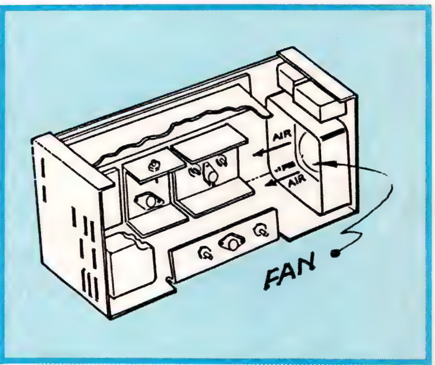
Contact us for more information on TOREMA toroidal transformers–we'll feed it to you in a hurry.

TOREMA
TRANSFORMERS

Torema U.S.A., Inc.
6699 Portwest Dr. / 130
Houston TX 77024
(713) 861-6643

CIRCLE NO 27

go the extra mile...
LOWER
component-to-ambient temperature gradient throughout entire product line.



JETA's hybrid thermal design ensures the lowest component-to-ambient temperature gradients to keep your products running cool, calm and collecting data.

This construction actually utilizes the power supply's chassis to function as a heat sink—the result of JETA's mechanical engineering emphasis. After all, with everyone using more or less identical electronic components, how else are you going to make a better box? By having more M.E.'s devoted to superior thermal management.

For cooler operating high-current single and multiple output power supplies from 500 to 2200 watts, contact JETA.

See EEM pages D1706-1708

JETA POWER SYSTEMS, INC.
2675 Junipero Avenue ■ Signal Hill, CA 90806
Tel: 213/427-0095 ■ TWX: 510-101-1804 ■ FAX: 2134262417

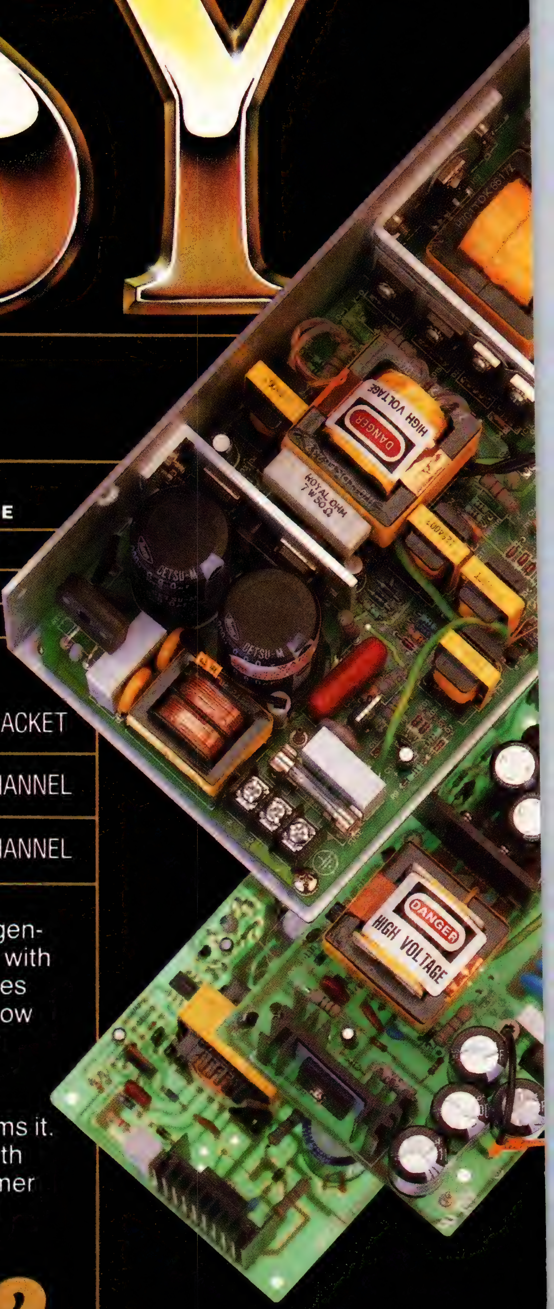
CIRCLE NO 28

EASY

40-220 WATT POWER SUPPLIES ARE NOW EASY TO SELECT...

Simply find the output configuration you need. And call. It's that EASY.

WATTS	MAIN	CH 2	CH 3	CH 4	MODEL No.	TYPE
40	+5V/2.5A	+12V/2.0A	−12V/0.1A		RBT 41	PCB
60	+5V/5.0A	+12V/2.5A	−12V/0.5A		RBT 61	PCB
70	+5V/6.0A	+12V/2.5A	−12V/0.7A	−5V/0.7A	RBQ 71	PCB
135	+5V/15A	+12V/4.0A	−12V/0.7A	−5V/0.7A	RBQ 131	L BRACKET
135	+5V/15A	+15V/3.2A	−15V/0.7A	−5V/0.7A	RBQ 132	
135	+5V/15A	+12V/3.0A	−12V/0.7A	+24V/1.5A	RBQ 133	
135	+5V/15A	+15V/2.4A	−15V/0.7A	+24V/1.5A	RBQ 134	
175	+5V/20A	+12 or 15V/4A	−12 or 15V/3A	−5V/1.0A	RBQ 171	U CHANNEL
175	+5V/20A	+12 or 15V/4A	−12 or 15V/3A	+24V/1.5A	RBQ 173	
220	+5V/25A	+12 or 15V/4A	−12 or 15V/3A	−5V/1.5A	RBQ 221	U CHANNEL
220	+5V/25A	+12 or 15V/4A	−12 or 15V/3A	+24V/3.0A	RBQ 223	



EASY TO QUALIFY

- UL, CSA, IEC 380/VDE 0806
- Replaceable internal fuse
- Full output to 50°C
- FCC 20780 & VDE 0871 level A
- 115/230 VAC selectable input
- Full power convection cooled

IT'S EASY TO SEPARATE VENDORS.

Just read on...

TALK TECHNICAL. Get answers to your technical questions. Today. Talk to one of our Technical Sales Engineers—located near you. Or call a member of our 40-220W Technical Staff. Who else offers such technical service?!

DELIVERY. We have a National Sales Organization and a nationwide Distribution Network to get your unit in your hands—quickly.

TEST DATA. Computer generated Test Data—furnished with every unit. The power supplies we ship you do work. You know it. We know it. The Test Data verifies it.

QUALITY. Everyone claims it. acdc electronics proves it with the industry's highest customer acceptance rate for over 30 years.

HARD?

HARD to find a 40-220W power supply that works? Not any more. The 40-220 power supply you need is on the shelf. Tested. Ready for shipment. Certain to pass qualification. And priced competitively. Just call 619/439-4200.
How HARD is that?

acdc electronics

401 Jones Road, Oceanside, CA 92054
TEL: 619/757-1880. TLX: 350227. FAX: 619/439-4243

1500w 800w 500w 300w 175w 70w 15w
1600w 1000w 750w 400w 220w 135w 40w

ACDC's POWER OFFERING

CIRCLE NO 223

STEPPER MOTORS

- *Provide 200 or 400 steps per revolution*
- *Holding torques range from 6.2 to 9.5 oz-in.*

These high-resolution, 1.8°, size 11 stepper motors feature an excellent torque-to-size ratio. Holding torques range from 6.2 to 9.5 oz-in. Dynamic torques span 3.9 to 5.9 oz-in. and the standard accuracy ranges within ±5%. These direct-drive motors feature ball-bearing construction and measure only 1.5 in. long by 1.067 in. wide. The motors deliver 200 or 400 steps per revolution in full- or half-step, bipolar or unipolar drive schemes. Special winding configurations and other custom modifications are available. From $20. Delivery, 90 to 120 days ARO.

Clifton Precision, Litton Systems Inc, Box 160, Murphy, NC 28906. Phone (704) 837-5115. TWX 510-935-1068.

Circle No 393

PROTECTION DIODES

- *Protect data buses against electrostatic discharges)*
- *Provide short-circuit protection for data lines*

The TH6P04T6V5CL and TH6P05T25CL Transils, which feature eight bidirectional clamping diodes in a single 20-pin DIP, suit data-bus protection applications.

SWITCH MODE POWER
FIT FOR YOUR NEEDS

Case 21

750 Watts
5″x6.5″x10
Single Outputs
Up to 5V 150A
15A Auxiliary Mag
Amp Outputs

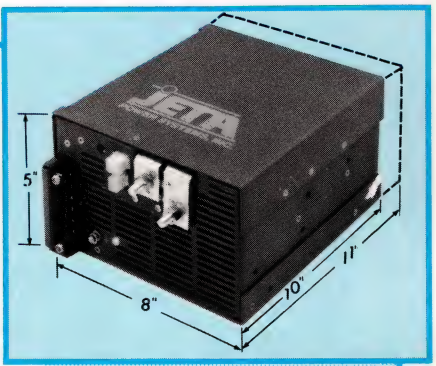
The power and flexibility you'd expect from 5X8X11 "slot" switching power supplies is now available with room to spare with the Qualidyne Case 21. Delivering 750 Watts from 1 to 7 fully regulated outputs. A unique package design that makes system connections a snap. A full assortment of standard features and options plus safety approvals and compliance with worldwide standards. Cut your power supply down to size with the Qualidyne Case 21.

THE SWITCHER FIT FOR YOUR NEEDS

Qualidyne

Qualidyne Systems, Inc.
3055 Del Sol Boulevard, San Diego, CA 92154
(619) 575-1100 Telex: 709 029 FAX: 619 429 1011
(800) 445-0425 In Calif. (800) 237-6885

CIRCLE NO 25



We'll give you
an inch...
and
1200
WATTS

Where other manufacturers require 11″ or more in a 1200 watt design, JETA gives you the same output power ratings *plus* an extra inch. So you can fit even more into your CAD/CAM/CAE systems, mini-main frames or communications products.

For compact high-current single and multiple output power supplies from 500 to 2200 watts, contact JETA.

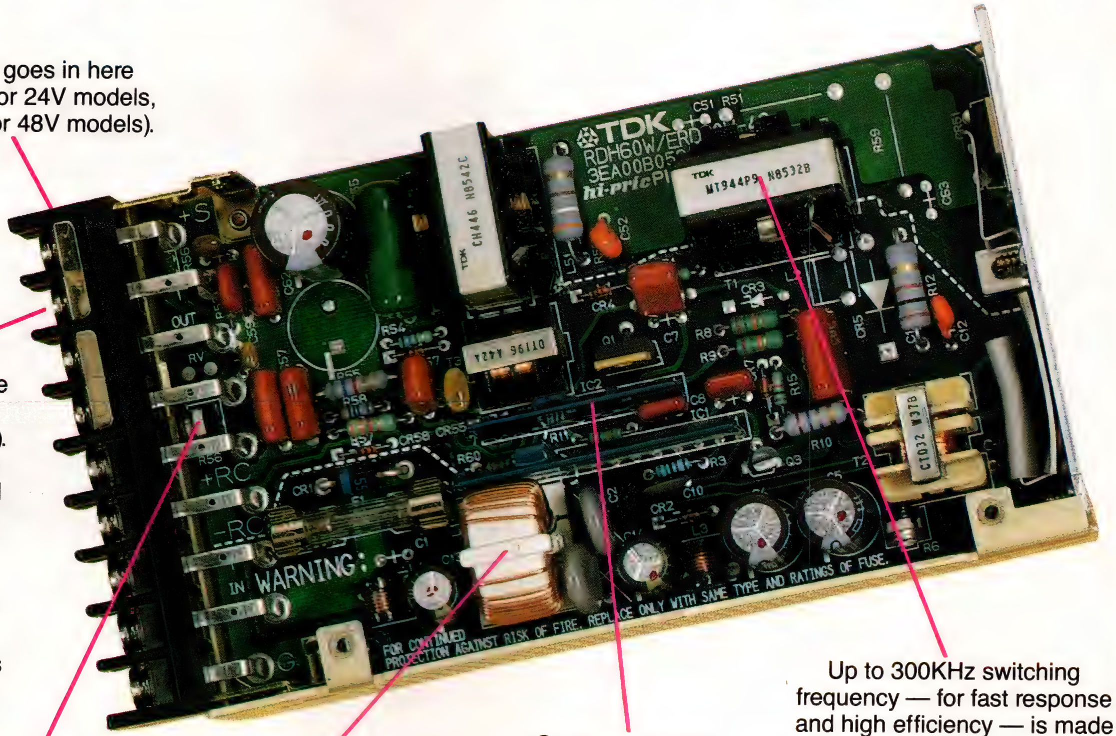
See EEM pages D1706-1708

JETA POWER SYSTEMS, INC.
2675 Junipero Avenue ■ Signal Hill, CA 90806
Tel: 213/427-0095 ■ TWX: 510-101-1804 ■ FAX: 2134262417

CIRCLE NO 26

How to turn the d-c you have into the d-c you want.

Pass it through a KEPCO/TDK ERD d-c to d-c converter


TDK
RDH60W/ERD
WARNING:
FOR CONTINUED PROTECTION AGAINST RISK OF FIRE, REPLACE ONLY WITH SAME TYPE AND RATINGS OF FUSE.

Your d-c goes in here (20~30V for 24V models, 40~56V for 48V models).

The d-c delivered here is stabilized to better than 0.2% (typ). As you increase your load to the rated load current, the voltage will remain constant within 0.3% (typ).

The input can be of either polarity, because the output is transformer-isolated from the input, and is fully floating off ground.

You can adjust the output voltage with a trimmer reachable through the enclosure.

Onboard EMI filter reduces the conducted noise fed back on your input bus within the limits of MIL-STD-461B.

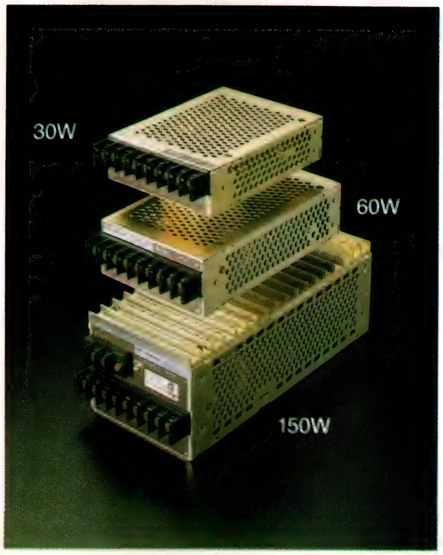
Our custom hybrid microcircuits (surface mount components on alumina substrates, sealed against moisture) reduce parts population, improve reliability.

Up to 300KHz switching frequency — for fast response and high efficiency — is made possible by a new, very low-loss TDK ferrite.

The model shown is our ERD 15-10-48. Output is 15V/10A; input is 48V.

Kepco d-c to d-c converters are not simple "regulators". They are full-fledged power supplies that do for your d-c everything that a-c to d-c voltage stabilizers do for the power company's a-c. Important features built into all models include:

- Self-contained heat sinks, convection cooled (no need to bolt an ERD to an external cold plate).
- Remote error sensing (allows for a voltage drop up to 0.4V in the wires to the load).
- Remote on/off (an optically isolated TTL logic control).
- Rectangular current limit (allows you to drive non-linear loads, parallel units, and use redundancy paralleling).
- LED power OK status indicator.



- Overvoltage protector (reduces the output to zero if the voltage tries to exceed the preset limit).
- Three sizes: 30 Watts, 60 Watts, and 150 Watts.
- Low cost, immediate availability.
- 5-Year warranty.

For more information or a demo for your lab, please write or call Dept. KRF-05,
KEPCO, INC., 131-38 Sanford Avenue,
Flushing, NY 11352 USA
(718) 461-7000 • TWX #710 582 2631
FAX (718) 767-1102.

KEPCO®
THE POWER SUPPLIER™

See us at Electro/88 • Kepco Booth 236, 238
CIRCLE NO 213

NEW PRODUCTS

COMPONENTS & POWER SUPPLIES

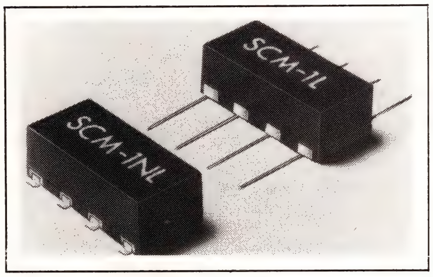
PROCESS INDICATOR

- *Combines alarm and indicator in one unit*
- *Accepts a wide range of process-level input signals*

The Model 40235 is designed for applications where both an alarm and an indicator light are needed in the same panel space. Standard features include a metal ⅛-DIN case, a 0.56-in. LED display, 12 or 24V dc outputs for driving external transducers or 2-wire current transmitters, a relay output rated for 8A at 115V ac, and screw-terminal wiring connections. You can select common process-level signal inputs, such as 4- to 20-mA, 1 to 5V, or 0 to 10V. You can also choose the display offset (within ±2000 counts) and the full-scale spans (10 to 2000). An extra right-hand digit (dummy zero) is available when needed to display in a count-by-10 mode. Front-panel controls include pushbutton setpoint display and setting, deadband range (0.1 to 10% of span), and zero and span adjustments. $249.

Extech Instruments Corp, 150 Bear Hill Rd, Waltham, MA 02154. Phone (617) 890-7440.

Circle No 390



RF MIXERS

- *Operate from 1 to 500 MHz*
- *−55 to +100°C temperature range*

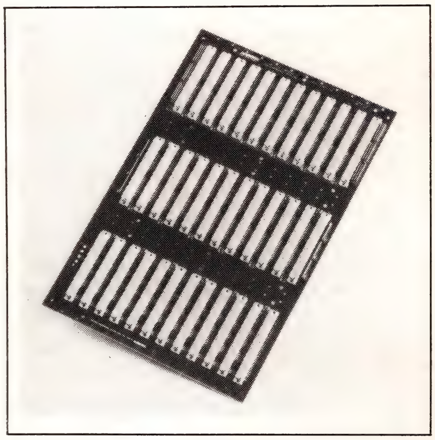
Offering a 1- to 500-MHz operating range, SCM-1 RF mixers work with a 7-dBm local-oscillator (LO) output and have a 6-dB conversion loss. LO to RF and LO to IF isolation measure 45 and 40 dB, respectively. The 1-dB compression point is 1 dBm. Two versions are available; the SCM-1L with leads, and the SCM-1NL without leads. Both have solder connections on the edge to improve soldering reliability. Each unit is housed in a nonhermetic plastic-ceramic package that measures 0.8×0.4×0.3 in. Operating range is −55 to +100°C. $2.49 (1000).

Mini-Circuits Lab, 2625 E 14th St, Brooklyn, NY 11235. Phone (718) 934-4500.

Circle No 391

BACKPLANE

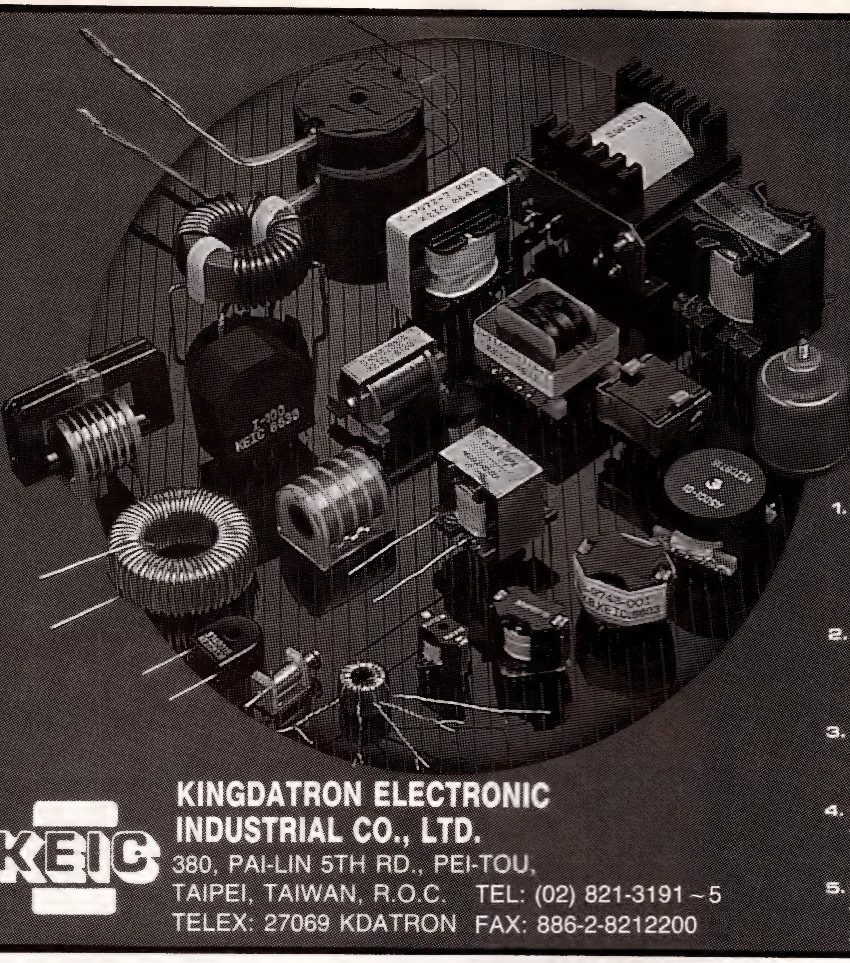
- *Compatible with both VME and Sun card cages*
- *Features a combined microstrip and stripline design*



This 12-slot, 9U backplane meets all specifications for any Sunbus models requiring such a configuration. Based on transmission-line technology, the backplane is mechanically compatible with both VME and Sun card cages. It duplicates the Sun backplane and includes the signal busing necessary to implement the Sun proprietary P2 bus. The 5-layer combination microstrip/stripline design provides high-performance operation as high as 40 MHz. Bus bars facilitate the power hook-up and disconnection. $1275.

Dawn VME Products, 47073 Warm Springs Blvd, Fremont, CA 94539. Phone (415) 657-4444.

Circle No 392



EUROPEAN AGENT WANTED

DESIGN TO MEET
UL, VDE & IEEE
REQUIREMENTS

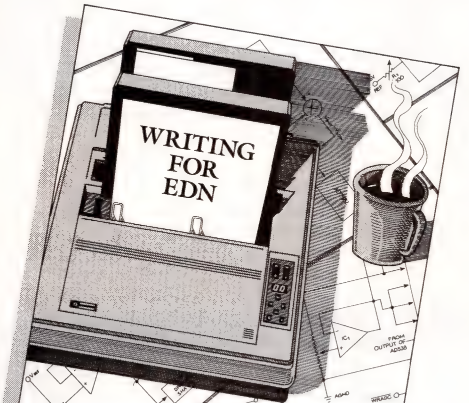
CUSTOM MAGNETICS

1. SWITCHING POWER TRANSFORMERS
   TYPES: VOLTAGE, CURRENT, LINE FILTER, DRIVE
   APPLICATIONS: COMPUTER, TELECOM, INDUSTRIAL
2. AUDIO TRANSFORMERS
   TYPES: SIGNAL, POWER
   APPLICATIONS: AUDIO, TELECOM, DATACOM, MILITARY
3. HIGH-VOLTAGE TRANSFORMERS
   TYPES: POWER, PULSED
   APPLICATIONS: IGNITION, INDUSTRIAL
4. CRT MAGNETICS
   TYPES: LINEARITY, WIDTH
   APPLICATIONS: TV, MONITORS
5. PULSE TRANSFORMERS
   TYPES: MATCHING, PULSED
   APPLICATIONS: DATACOM, TELECOM

KEIC
KINGDATRON ELECTRONIC
INDUSTRIAL CO., LTD.
380, PAI-LIN 5TH RD., PEI-TOU,
TAIPEI, TAIWAN, R.O.C. TEL: (02) 821-3191 ~ 5
TELEX: 27069 KDATRON FAX: 886-2-8212200

CIRCLE NO 108

Turn Good Ideas Into Good Articles



With EDN's FREE Writer's Guide!

Would you like to get paid for sharing your clever engineering ideas and methods with your professional colleagues? If so, then send for EDN's new FREE writer's guide and learn how.

You don't need the skills and experience of a professional writer. And you don't need to know publishing jargon. All you *do* need are a little perseverance, your engineering skills, and the ability to communicate your ideas clearly.

Our new writer's guide takes the mystery and intimidation out of writing for a publication. It shows you how to write for EDN using skills you already have. Plus, it takes you step-by-step through the editorial procedures necessary to turn your ideas into polished, professional articles.

Get your FREE copy of EDN's writer's guide by circling number 800 on the Information Retrieval Service Card or by calling Sharon Gildea at (617) 964-3030.

Now it's safe to switch HI-506A-HI-509A MUXs.

MODEL	HI3-0506A-5	HI1-0506A-5	HI1-0506A-2	HI3-0507A-5	HI1-0507A-5	HI1-0507A-2	HI3-0508A-5	HI1-0508A-5	HI1-0508A-2	HI3-0509A-5	HI1-0509A-5	HI1-0509A-2
Channels												
Single Ended	16	16	16				8	8	8			
Differential				8	8	8				4	4	4
Temp Range (°C)	0/+75	0/+75	−55/+125	0/+75	0/+75	−55/+125	0/+75	0/+75	−55/+125	0/+75	0/+75	−55/+125
Package	28-Pin Plastic DIP	28-Pin CERDIP	28-Pin CERDIP	28-Pin Plastic DIP	28-Pin CERDIP	28-Pin CERDIP	16-Pin Plastic DIP	16-Pin CERDIP	16-Pin CERDIP	16-Pin Plastic DIP	16-Pin CERDIP	16-Pin CERDIP

Drop-in replacements
Our new CMOS analog multiplexers are identical, drop-in replacements for the "other" HI-506A series parts. Same performance. Same pin-outs. Same dielectric isolation. Same circuit behavior. Same model numbers and data sheets.

Proven quality, fast delivery
We make these MUXs completely, from silicon to stock. We control production and quality throughout to make sure you get the parts you need when you need them.

Key HI-506A/509A Features

- input overvoltage protection to 70Vp-p
- ±15V signal range
- break-before-make switching
- 3.5μs max settling time (0.01%)

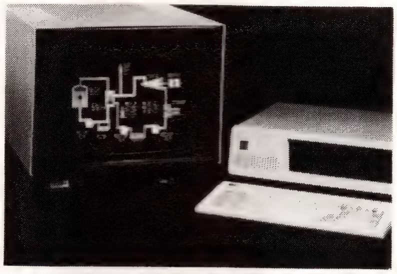
Call us today for samples and quotes. Contact our nearest sales office or Applications Engineering, 602/746-1111. Burr-Brown Corp., P.O. Box 11400, Tucson, AZ 85734.

BURR-BROWN®

CIRCLE NO 214

EGA MONITOR

- *Provides automatic sync from 20 to 33 kHz*
- *Preconverged CRT has trio dot pitch of 0.31 mm*



The EG2040 Model 1 19-in. monitor for the IBM PC/AT and compatible computers runs with an IBM EGA card or compatibles; it adjusts to resolutions from 640×350 to 640×480 pixels as well as other resolutions in the 20- to 33-kHz range. The preconverged CRT has a trio dot pitch of 0.31 mm. The vertical scan frequency ranges from 40 to 100 Hz. The video bandwidth is 65 MHz and the user controls include power, brightness, and degaussing. The TTL inputs provide a color palette of 16 out of 64 colors. The monitor is available in a 19-in. metal enclosure or a RETMA standard 19-in. rack mount. From $1587.

Colorgraphic Communications Corp, Box 80448, Atlanta, GA 30366. Phone (404) 455-3921.

Circle No 386

Instead, Let Eagle Squelch The Problem

Solving your own EMI problems can be as difficult as killing seven flies with one blow. Using custom engineered magnetic shielding, Eagle can design and manufacture a dependable solution.

With over 18 years of continuous service, Eagle's technical experts offer support in custom and standard magnetic shield designs, engineering and proper material selection.

An Eagle solution is a superior technological investment that will save you both time and money. We're dedicated to solving your specific EMI problems with the most original and up-to-date design engineering available.

So, whether for prototype, small quantity or large volume capability, you can trust Eagle to respond with quality, reliable shields delivered on time.

Call Eagle at (317) 297-1030 for problem design assistance, or write for FREE engineering design information packet #03 and let us handle the squelching.

EAGLE MAGNETIC COMPANY, INC.

Eagle Magnetic Company, Inc. • P.O. Box 24283
Indianapolis, Indiana 46224 • (317) 297-1030 • FAX 317-299-1323

CIRCLE NO 24

DISK CONTROLLER

- *Achieves average access time of 3 msec*
- *Host-to-controller transfer rate is 4M bytes/sec*

The Ten Time caching disk controller for the IBM PC, PC/AT, and compatible computers contains a cache RAM with battery backup that controls as many as two ST506/412 disk drives, achieving an average disk access time of 3 msec. The board also controls two floppy-disk drives. The caching algorithm produces 90 to 95% hits in most applications. Consequently, the effective transfer rate of all data requests is 4M bytes/sec. A zero-latency read allows the drive to start reading and transferring data immediately, regardless of which data sector the head lands on. $595.

Konan Corp, 4720 S Ash Ave, Tempe, AZ 85282. Phone (602) 345-1300.

Circle No 387

THE ONLY THING MISSING FROM THIS 680-PAGE LEADED RESISTOR/CAPACITOR DATA BOOK IS *YOU.*

ORDER YOURS NOW.

MEPCO/CENTRALAB
A NORTH AMERICAN PHILIPS COMPANY
1988-89
Resistor/Capacitor Data Book

DN 4/28

Mail to: Mepco/Centralab, Attn: Corp. Advertising
2001 W. Blue Heron Blvd., Riviera Beach, FL 33404

New 680-page 1988-89 Leaded Resistor/Capacitor Data Book contains valuable performance and specifying data on the complete, broad line of Mepco/Centralab leaded passive components:

- Ceramic capacitors
- Tantalum capacitors
- Aluminum electrolytic capacitors
- Film and variable capacitors
- Fixed film resistors and networks
- Non-linear resistors
- Cermet trimmers

And ask for our data book on America's broadest line of SMD® passive components, too!

Please send me these specification guides:
☐ **New Leaded Resistor/Capacitor Data Book**
☐ **New Surface-Mount Device Catalog**

Name ____________________
Title ____________________
Company ____________________
Dept./Div. ____________________
Address/MS ____________________
City ____________________
State/Zip ____________________

MEPCO/CENTRALAB
A DIVISION OF NORTH AMERICAN PHILIPS CORPORATION

PHILIPS PHILIPS

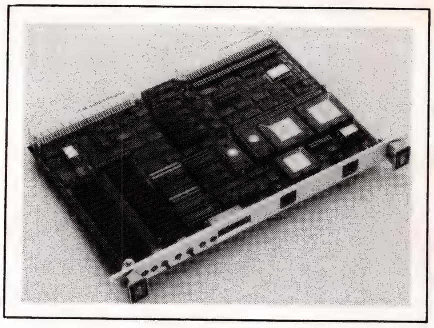
®SMD is a service mark of North American Philips Corporation.

CIRCLE NO 215

DEC-standard device; DMA accesses over the Q-bus are accomplished via dual-port buffers. The Transputer links operate at data rates of 5M, 10M, or 20M bytes/sec. The IMST212 Transputer provides local intelligence for each link with independent subsystem control. The board comes with device-driver software and benchmark applications. Linked to the VAX via the QT0's Transputer links, one or more QT4 boards allow you to configure a Transputer array with the required topology. Each board houses as many as four IMST414 or four IMST800 32-bit Transputers, each provided with 1M byte of dynamic RAM. You can select the cycle time of the Transputers, and the board will accept the Inmos IMST800-30 Transputer without modification. To create a multiuser program-development environment, you can use the boards with the Inmos stand-alone Occam Micro-VMS tool set. QT0 £1795; QT4 with IMST414 Transputer £3995.

Caplin Cybernetics Corp Ltd, 47 Cannon Drive, London E14 9SU, UK. Phone 01538 1716. Fax 01-538 4151.

Circle No 384



32-BIT CPU BOARD

- *25-MHz 68020 CPU and 1M byte of RAM for VME Bus*
- *Real-time processor with memory protection*

The MZ 7122 32-bit CPU board for the VME Bus features a 25-MHz 68020 CPU, 1M byte of dual-ported RAM with parity, as much as 128k bytes of EPROM, two RS-232C ports, and a time-of-day clock with battery backup. It has a 32-bit master/slave interface to the VME Bus along with an interrupt handler, an interrupt generator, a mailbox interrupt, and controller functions with 4-level arbitration. Its options include a VSB memory expansion interface, a 68851 paged-memory-management unit, and a 68881 or 68882 floating-point coprocessor. Software support for the board includes VRTX/32 Real-Time Executive from Ready Systems, OS-9 from Microware Systems, and PDOS from Eyring Research. $2695.

Mizar Inc, 1419 Dunn Dr, Carrollton, TX 75006. Phone (800) 635-0200; in TX, (214) 446-2664. TWX 510-600-4272.

Circle No 385

FREE HYBRID ANSWERS

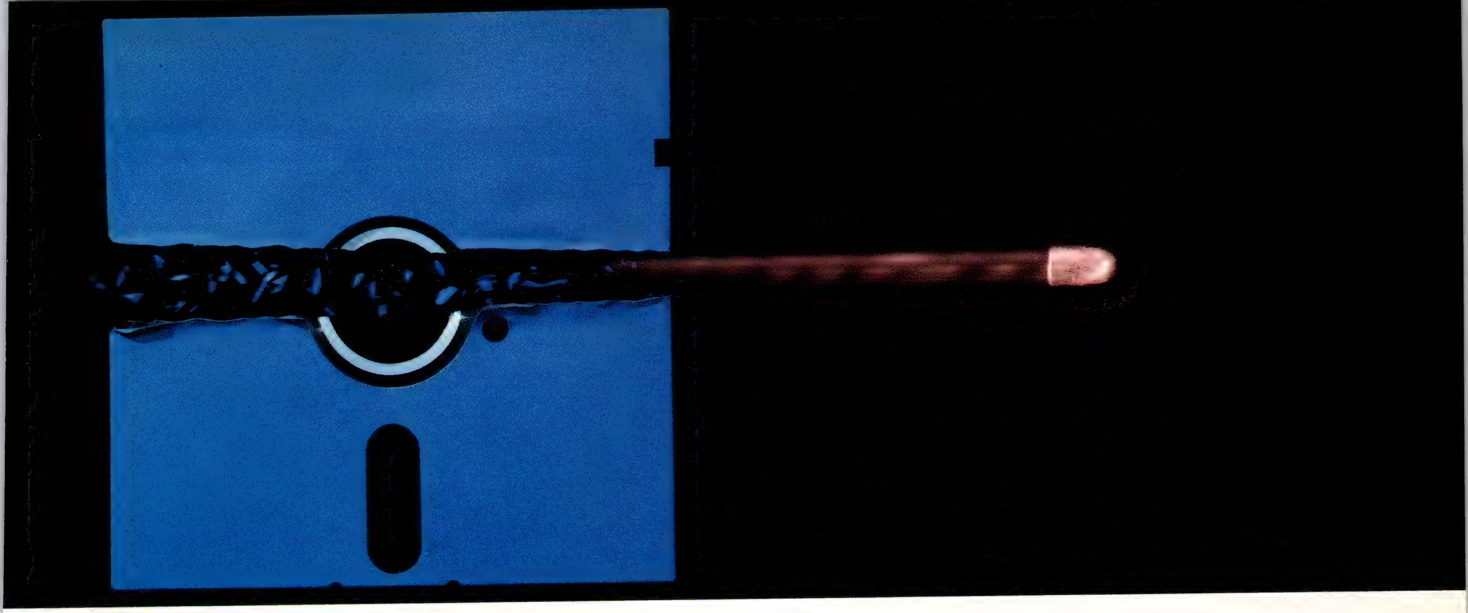
When is it practical to develop a custom hybrid? What about my specific circuit requirements? What are the costs, and how long does it take?

Get fast answers to these important hybrid questions with HEI's Express Quote Service. Call, write or FAX today for your HEI Express Quote Kit, and we'll respond promptly with clear answers and without obligation.

HEI has 20 years of experience in custom hybrid circuit development. The company offers innovative hybrid design and manufacturing capabilities, fast service, and consistent production quality.

HEI inc.
HYBRID ELECTRONICS DIVISION
Box 5000, 1495 Steiger Lake Lane, Victoria, MN 55386
Phone: 612-443-2500 FAX: 612-443-2668

CIRCLE NO 23



NEW AVOCET C™ FOR MICROCONTROLLERS-A BREAKTHROUGH IN SPEED AND QUALITY.

Introducing Avocet C.™ Fast, *optimizing* cross-compilers that can cut microcontroller development time in half—without sacrificing code quality.

From concept to code in a fraction of the time.

Programming in C lets you concentrate on end results, not annoying details—so you get more done, faster. And rapid compilation takes the frustration out. But for microcontrollers, you need more than speed. You need tight, high-quality code.

That's why we spent two years field-testing and perfecting Avocet C for both speed and quality. We built in three separate phases of optimization—for object code tight enough for real applications. And we integrated Avocet C with an assembler package that's mature in its own right—not an afterthought. So you can still work magic at the bits-and-bytes level.

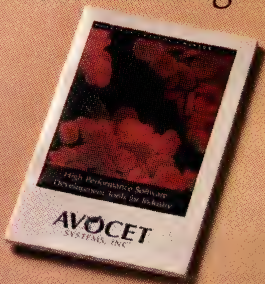
Avocet C saves you time in all phases of development. Our run-time library is extensive—no need to write the routines yourself. You'll arrive at bug-free code faster, thanks to LINT-like type checking. And your program's useful life is extended, because you can recompile for other target chips.

Testing is easier, too. Avocet C is ANSI-standard—so you can test generic parts of your program with host-resident systems like Microsoft Quick-C™ and Codeview.™ And when you're ready for hardware-specific testing, Avocet's AVSIM Simulator/Debugger tests microcontroller code right on your PC.

An excellent value.

Just $895 buys Avocet C for your favorite chip: Intel 8051 or 8096, Hitachi 64180, or Zilog Z80—with more to follow. And Avocet C includes the latest version of AVMAC—Avocet's super-fast, professional assembly-language development package. *(If you're already a registered AVMAC owner, you can upgrade to Avocet C for only $595.)*

Free Catalog



Call Toll-Free
800-448-8500*

For your free Avocet catalog—to order—or for more information about Avocet C and other Avocet products.

The best technology—responsive, personal service.

Avocet offers a powerful, comprehensive approach to microcontroller development.

Avocet development tools put the most advanced technology at your fingertips. The Avocet staff stands ready to give you complete support—including technical assistance—on a moment's notice. And we'll ship your order in 48 hours or less.

Call 800-448-8500. Discover how Avocet can speed up your next project.

Avocet Systems, Inc., 120 Union Street
P.O. Box 490BP, Rockport, Maine 04856
*In Maine, or outside U.S., call (207) 236-9055
TLX: 467210 Avocet CI, FAX: (207) 236-6713

© 1988 Avocet Systems, Inc. All rights reserved. Quick-C and Codeview are trademarks of Microsoft Corp. Logo and name Avocet are registered trademarks of Avocet Systems, Inc.

AVOCET
SYSTEMS, INC.®
THE SOURCE FOR QUALITY PERSONAL μP DEVELOPMENT TOOLS.

CIRCLE NO 216

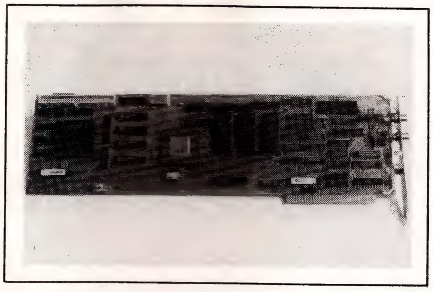
Ethernet port. The systems support bit-mapped graphics displays, using 68020 display processors. A 17-user System 22, $19,000; a 70-user System 22E, $56,000.

Counterpoint Computers, 2127 Ringwood Ave, San Jose, CA 95131. Phone (408) 434-0190. TLX 856884.

Circle No 382

DEVELOPMENT BOARD

- *For Analog Devices' ADSP-2100 digital signal processor*
- *System comes with a debug monitor and simulator*



The ADSP-2100 development system for the IBM PC, PC/XT, PC/AT, and compatible computers can develop software for the Analog Devices' ADSP-2100 Digital Signal Processor. It comes with a debug monitor and Analog Devices' Cross-Software and Simulator. The board comes with 8k×24 bits of program memory that has a 45-nsec access time. The program memory is expandable on board to 32k×24 bits, and the data memory is 8k×16 bits expandable off board to 16k×16 bits. Both memories are dual-ported to the PC. The system includes a 200-kHz, 12-bit A/D converter and a D/A converter. The converters can be clocked externally or from an onboard 16-bit timer running at 4 MHz. The debug monitor controls all of the board's functions, providing memory-access commands, register examination, breakpoints, and a Help facility. ADSP-2100, including PC plug-in board, debug monitor, documentation and Cross-Software and Simulator, $2995; without Cross-Software and Simulator, $2595.

Spectrum Signal Processing Inc, 460 Totten Pond Rd, Waltham, MA 02154. Phone (800) 323-1842; in MA, (617) 890-3400.

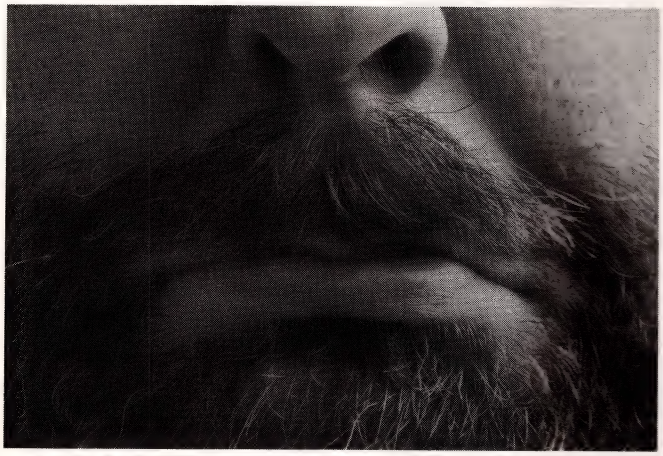
Circle No 383

TRANSPUTER BOARDS

- *Provide parallel processing for DEC MicroVax computers*
- *Compatible with Inmos' Micro-VMS tool-set software*

Using the QT0 and QT4 Q-bus-compatible Transputer boards, you can add the parallel-processing power of Transputer arrays to MicroVax computers. The QT0 contains a single IMST212 Transputer that provides a bridge between the Q-bus and four Transputer links. Each link appears to the VAX as a separate

THEIR PROBLEM. OUR PROBLEM.



For years, metallurgists have known that pure-tin-plated board surfaces can grow nasty circuit-killing "tin whiskers" over time.*

Makes you wonder why some board suppliers would use pure tin and risk such failure in the first place.

Standard Logic wouldn't. Our boards have always used a lead-tin alloy for plating material. So tin whiskers wouldn't ever grow. And there'd never be a problem.

Our problem? It's just that we're not so well known.

So we're letting you know that Standard Logic is now delivering the highest-quality, whisker-free logic cards in the packaging business.

45 different DIN-standard designs are available. They're compatible with the major bus interfaces and are the only ones with built-in decoupling capacitors.

Take advantage of this now and by next year maybe we'll be famous, too.

Write: Standard Logic Inc., 4940-A E. La Palma Ave., Anaheim, CA 92807. Or call 714/779-2897 today.

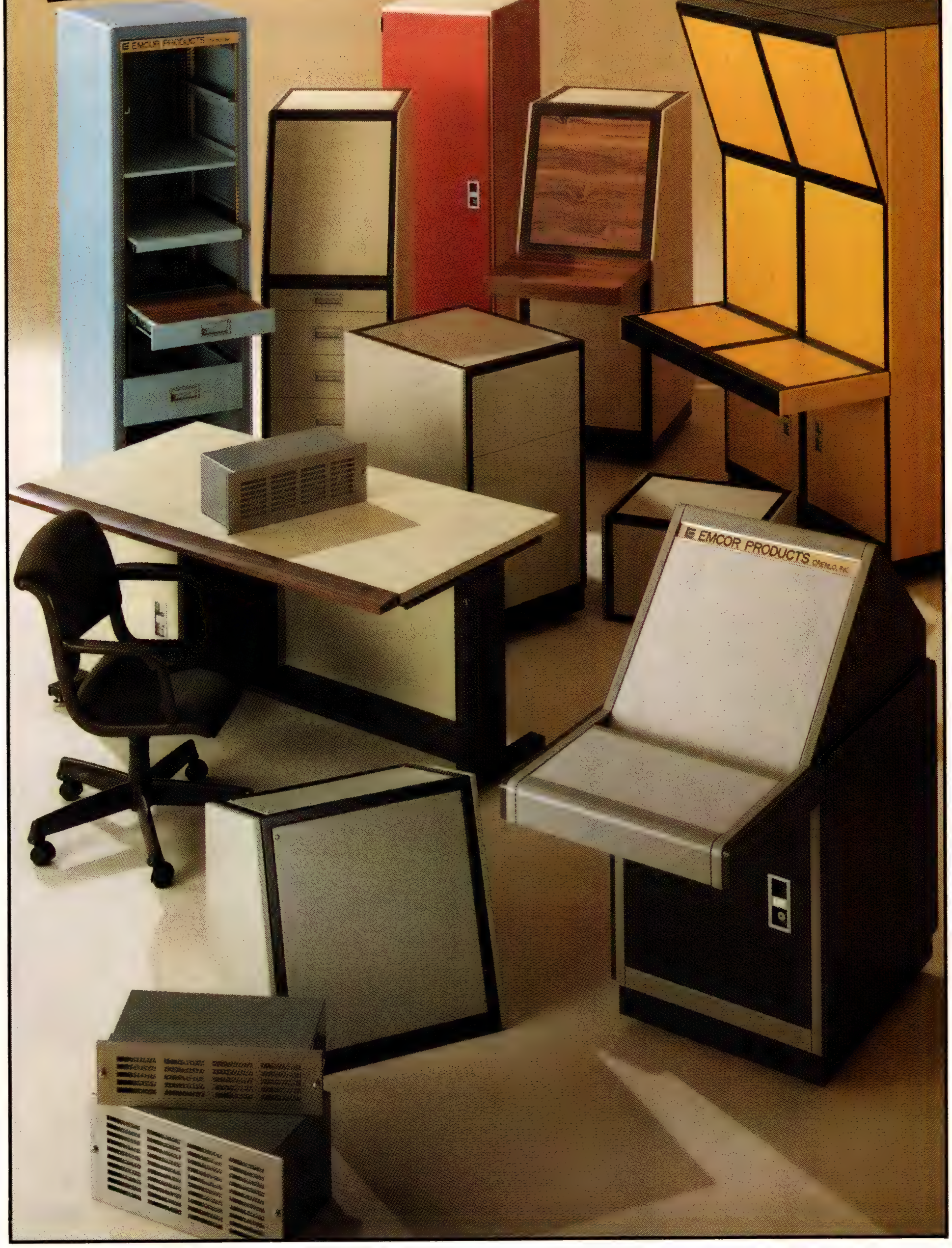
STANDARD LOGIC INC.
Bringing your designs to life.

*Learn more about the "tin whisker" problem. Write for free IEEE Spectrum article reprint.

CIRCLE NO 22

See us at ELECTRO, Booth 2137

When your specs call for quick shipment, *call for Instant Emcor*



You're looking for the best enclosure to meet your specifications, but you also need it immediately. The solution — specify Instant Emcor. Get exactly what you need shipped to you within 5 working days.

Pictured are just a few of the enclosure options available to you from Instant Emcor. It's the broadest, most comprehensive stocking plan in the industry. Choose from vertical, desk height, slope front, low silhouette and turret configurations — all available with a full complement of accessories. There's also a line of computer support furniture.

Emcor doesn't make you order from a pre-assembled, preboxed inventory, so you're not forced to purchase unwanted accessory items. Instead, Emcor's top-quality enclosures are fully assembled in single bay units to your specifications and shipped within 5 working days. Order one enclosure or many. In addition to the standard colors, there's an option of 16 colors on a group of our most popular ESQ items, with shipment in 10 working days.

Emcor was first with a ship from stock program. Today, we're still the industry leader with the broadest, most flexible program. Call us today to see how we can help you.

Crenlo, Inc.
1600 - 4th Ave. N.W.
Rochester, MN 55901
Phone 507-289-3371
TWX #9105652374
FAX #507-287-3405

EMCOR

See us at the Electro Show, Booth #1456-1458.

CIRCLE NO 217

and Unix operating systems. At the heart of the controller is the company's AIC-011 programmable media sequencer and the AIC-6225 bipolar monolithic data separator. The board has a data-to-disk transfer rate of 5M bps with full-track buffering and a read-ahead cache. An optional 8k-, 32k- or 64k-byte buffer is available. $160 (1000).

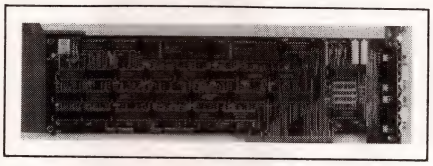
Adaptec Inc, 580 Cottonwood Dr, Milpitas, CA 95035. Phone (408) 432-8600.

Circle No 380

RS-422A BOARD

- *Fit in IBM's PS/2 Models 50, 60, and 80 computers*
- *Two serial ports have data rates from 50 to 256k baud*

The DS-2000 communications board for the IBM PS/2 Models 50, 60, and 80 has two independent RS-422A interfaces. Balanced-line serial drivers and receivers provide communications to a limit of 4000 ft. D-9 connectors provide noise rejection when communications occur through shielded cables. A 16550 asynchronous communications element, containing a UART and a programmable baud-rate generator, controls each port. The transmission rate of each interface is individually programmable from 50 to 256k baud. The address and the interrupt used by each port are selectable. The possible addresses include COM1 through COM8, and the possible interrupts include IRQ3, IRQ4, IRQ7, and IRQ9. $395.



Qua Tech Inc, 478 E Exchange St, Akron, OH 44304. Phone (216) 434-3154. TWX 510-101-2726.

Circle No 381

68020 COMPUTERS

- *192 users at a time can use Unix System V-type system*
- *Mountable in 19-in. industry-standard racks*

As many as 192 users can log onto the System 22 and System 22E 25-MHz 68020 computers at the same time. The systems run the C-XIX 3.0 operating system, the company's enhanced multiprocessor version of AT&T's Unix System V, Rel 3.0. The System 22 has 4M bytes of parity-checked RAM and is expandable to 96M bytes; the System 22E has 4M bytes of RAM with error-correction code and is expandable to 128M bytes. Using from one to 10 modules, you can expand the systems to achieve computing power as high as 32 MIPS. The systems also include a file I/O processor, a 180M-byte Winchester disk, a 60M-byte cartridge tape, a Centronics parallel port, a SCSI port, and an

Tough, Sensitive Electret Mike

The electret microphone RLC 104 can withstand the toughest environment while still performing better than any other.

Between arctic —40°C and tropical +70° C you'll always get super-sensitive performance, about 10 dB better than from the best competitor. The low-mass diaphragm renders the mike insensitive to mechanical vibrations. The signal-noise ratio can't be beaten. A built-in IC handles impedance conversion and a capacitor handles RF-interference.

The microphone can be used both for handsets and loud-speaking telephones. With only two terminal contacts it is designed for fast, automatic or manual assembly without soldering. Terminals can be supplied bent at 90° to adapt to your specific design.

With our mike, you get the best.

ERICSSON

ERICSSON COMPONENTS AB
Telecomponents Department
S-164 81 KISTA-STOCKHOLM, SWEDEN
Phone +468 757 4467 Telex/Teletex 8125008
Telefax +468 752 9265

ELECTRO -88
Show Booths 222-224

CIRCLE NO 21

ICADEM
Integrated Computer-Aided Design, Engineering, Manufacturing
Extending Every Limit Of Innovation...
GE PLASTICS

Power. Harnessed for you.

ICADEM: Integrated Computer-Aided Design, Engineering, Manufacturing. Phenomenal depth of software for productivity and performance. Humanizing technology. Earth-shaking opportunities accelerating product innovations.

Dynamic. Interactive. Beyond incomparable materials performance and advanced process development. A powerful matrix of resources. Only from GE.

Unleash the power to extend your innovations past every limit. Call now for exciting ICADEM details: (800) 845-0600.

GE Plastics

CIRCLE NO 218

configuration, which operates at 4 MIPS, includes 16M bytes of memory, 300M bytes of disk capacity, a tape cartridge, and an Ethernet interface. An 11-slot Nanobus backplane transfers data at 100M bytes/sec. The modular parallel-processing boards are based on National's NS32032 and NS32332 μPs, which can support as many as 200 users. From $89,000 to $500,000. Delivery, 60 days ARO.

Encore Computer Corp, 257 Cedar Hill St, Marlborough, MA 01752. Phone (617) 460-0500.

Circle No 378

BREAKOUT BOX

- *Monitors 15 RS-232C lines with red and green LEDs*
- *Data lines illuminate the LEDs*

The Easy Bob Model 725 breakout box for monitoring RS-232C lines has two 3-in. ribbon cables with dual-gender DB25 connectors for easy insertion into an RS-232C line. The box monitors 15 lines with red and green LEDs. Positive voltages illuminate the red LEDs, and negative voltages illuminate the green LEDs. One spare LED set (red and green) is positioned at the top center of the unit to monitor lines other than those with dedicated LEDs. You can enable the 25 monitor points, using 25 DIP switches—one for each line of the connector. Each point has a socket which accepts a jumper wire to configure different interconnections. The unit requires no power or batteries; the voltage on the data lines illuminates the LEDs. It comes complete with jumper wires and an operator's manual. $99.

Beckman Industrial Corp, 3883 Ruffin Rd, San Diego, CA 92123. Phone (619) 495-3224.

Circle No 379

CONTROLLER BOARD

- *For IBM PS/2, Models 50, 60, 80, and compatibles*
- *Provides 10M-byte/sec DMA transfer rate*

You can use the ACB-2610 controller board for the ST412/506 MFM hard-disk-controller board with the IBM PS/2 Models 50, 60, 80, or a compatible computer. It features 1:1 sector interleaving and a host DMA transfer rate of 10M bytes/sec. The board runs with MS-DOS, OS/2, Xenix,

PSR/NSR: THE LITTLE SWITCHING REGULATORS WITH THE GREAT PERFORMANCE.

The most important values:

Input: 7 to 80 VDC
Output: 15 to 288 W
Ambient temperature: -40 to +71°C
Efficiency: up to 95%

RFI-shielded and self cooling metal cases. Positive and negative supplies with many interesting features and options.

Ask for detailed information and for the application note nr. 2

SUPPLYING GREAT PERFORMANCE:

MELCHER

MELCHER AG, CH-8610 Uster/Switzerland, Ackerstr. 56, Tel. 01-941 37 37
MELCHER INC., Natick, MA 01760, 10 Cochituate Str., Tel. 617 653 9979
See us at ELECTRO, Booth #509

b2us

CIRCLE NO 20

Grayhill shrinks the I/O module

to save you space, money, and problems

This new series of space-saving I/O modules for control applications measures 0.40″ deep and 1.00″ high, compared to 0.60″ and 1.25″ for "standard" models, and reduces the length of a 16-module rack by 4 inches! (The wide side is the same 1.70″ as standard modules, for plug compatibility.)

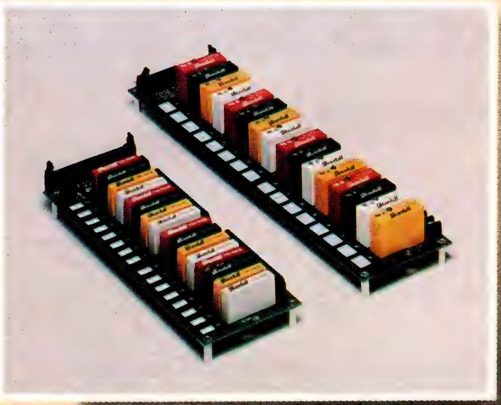
Grayhill mini-modules consume 30% less power than their big brothers, and offer immunity from false triggering caused by electrical transients (per IEEE-472). Using SMT construction, Grayhill shrinks the package, yet upgrades performance even compared to its own standard modules, much less anyone else's. AC output units have lower leakage current, DC output units offer faster switching, and AC input modules have a higher input impedance.

The new mini-modules come in all standard configurations, at pricing comparable to standard-size I/O modules.

They plug into 16 module racks without screws; a hold-down strip keeps them in place. Surface-mount LEDs with writing space provide status and function indication.

Using the new modules saves you cost at least four ways—you use a smaller rack, a smaller power supply, a smaller enclosure, and you save the labor of screwing modules into place. And you get better performance besides.

What else could you ask for? How about local availability from Grayhill distributors worldwide! You get that too. So now your next step is send or call for free literature. Do it today.



COMPARISON CHART

PHYSICAL CHARACTERISTICS	STANDARD I/O MODULES	MINI I/O MODULES
Module dimensions	0.60″x1.70″x1.25	0.40″x1.70″x1.00
16-position rack length	14″	10″
Installation	Individual screw-down	Hold-down strip
ELECTRICAL CHARACTERISTICS		
Power consumption/ module-AC output	18 milliamps	12 milliamps
Pass IEEE-472	No	Yes
Switching speed–DC output	75 μs turn on 500 μs turn off	20 μs turn on 40 μs turn off
Input impedance–AC input	14K Ohm (120 VAC) 45K Ohm (240 VAC)	22K Ohm (120 VAC) 60K Ohm (240 VAC)

Grayhill INC.

561 Hillgrove Avenue, P.O. Box 10373
LaGrange, Illinois 60525-0373 USA
Phone: (312) 354-1040 FAX: (312) 354-2820
TLX or TWX: 190254 GRAYHILL LAGE

AVAILABLE LOCALLY THROUGH THESE REPRESENTATIVES

AUSTRALIA/NEW GUINEA **Acme Electronics**
Kilsyth, Victoria • Tel: (011) (61) (3) 890 0900
BELGIUM/LUXEMBOURG **Rodelco SA/NV Electronics**
Zaventem • Tel: (011) (32) (2) 720 5013
CHINA, REPUBLIC OF **Morrihan International**
Taipei • Tel: (02) 752-2200
DENMARK **E.V. Johanssen Elektronik A-S**
Copenhagen • Tel: (011) (45) (1) 839022
FINLAND **OY Flinkenberg & Co., AB**
Helsinki • Tel: (011) (358) (0) 647311
FRANCE **Radio Television Francaise**
Gentilly • Tel: (011) (33) (14) 664-1101
GERMANY **Data Modul GmbH**
München • Tel: (011) (49) (89) 56 01 70
HONG KONG **Components Agent Ltd.**
Hong Kong • Tel: (011) (852) (0) 499-2688
INDIA **Hindco Corporation**
Bombay • Tel: (011) (91) (22) 493-1544
IRELAND, REPUBLIC OF **Neltronic Ltd.**
Dublin • Tel: (011) (353) (1) 501845
ISRAEL **Boran Technologies, Ltd.**
Petah Tikva • Tel: (03) 9240925
ITALY **Microelit s.r.l**
Milano • Tel: (011) (39) (2) 499 0444
Rome • Tel: (011) (39) (6) 889-4323
JAPAN **Jepico Corp.**
Tokyo • Tel: (011) (81) (3) 348 0611
NETHERLANDS **Rodelco BV Electronics**
Breda • Tel: (011) (31) (76) 78-4911
NEW ZEALAND **S.D. Mandeno**
Auckland • Tel: (011) (64) (9) 600-008
NORWAY **Hans H. Schive A/S**
Asker • Tel: (011) (47) (2) 90 09 00
SINGAPORE, REPUBLIC OF **Microtronics Associates Ltd.**
Singapore • Tel: (011) (65) 7481835
SOUTH AFRICA, REPUBLIC OF **Liberty Electronics (Pty.) Ltd.**
Boksburg • Tel: (011) (27) (11) 52 7637
SOUTH KOREA **Unistandard Corporation**
Seoul • Tel: (82) (2) 532-6815 16
SPAIN **Unitronics SA**
Madrid • Tel: (011) (34) (1) 242 52 04
SWEDEN **Bo Palmblad Aktiebolag**
Bromma • Tel: (011) (46) (8) 252720
SWITZERLAND **Walter Blum AG**
Zurich • Tel: (01) (41) (1) 312 68 72
UNITED KINGDOM **Highland Electronics, Ltd.**
Burgess Hill, West Sussex • Tel: (011) (44) (4) 446-45021

CIRCLE NO 224

plug-in cartridges or disk and are downloaded into the printer. The printers are compatible with IBM graphics printers and the Epson FX-80. Model 4/20, $645; Model 4/21, $899.

Honeywell Bull Inc, 300 Concord Rd, Billerica, MA 01821. Phone (617) 671-2517.

Circle No 376

Q-BUS COMPUTERS

- *Runs PDP-11 operating system*
- *Has as much as 4M bytes of onboard memory*

Based on DEC's J11 µP and an optional FPJ11 floating-point accelerator, the SBCM80 and SBCM90 Q-bus single-board computers are fully compatible with PDP operating systems and software—for example, RSX, RSTS, RT-11, Unix, DSM, BOS, and TSX. They plug directly into standard 22-bit Q-bus backplanes and are downward compatible with the 16- and 18-bit LSI-11 bus. The M80 runs at a clock frequency of 15 MHz, and the M90 runs at a clock frequency of 18.5 MHz. Both boards are available with 1M to 4M bytes of zero-wait-state, parity-checked dynamic RAM. You can expand the memory of the 1M-byte versions to 4M bytes with off-board memory. The boards support normal- and block-mode DMA transfers between the onboard dynamic RAM and other Q-bus modules. Additional onboard facilities include four DLV11-J compatible serial I/O lines, space for 32k bytes of bootstrap EPROM, and a real-time clock. Most of the board's functions are software configurable via EEPROM, and the bootstrap firmware allows you to sequence through as many as six boot devices during system initialization. M80 with 1M-byte dynamic RAM, £2500; M90 with 4M-byte dynamic RAM £5150 (50).

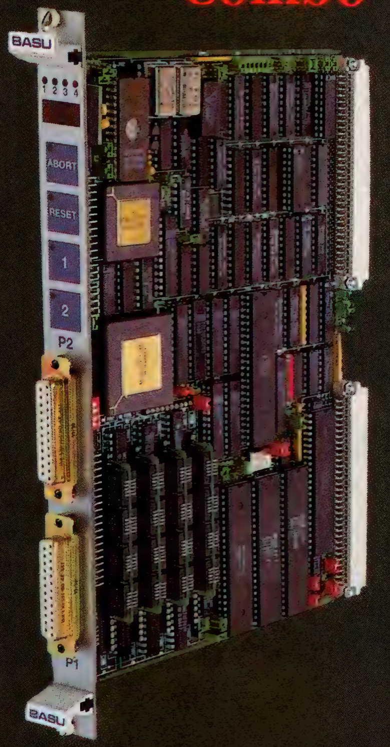
Mentec Computer Systems Ltd, Sandyford Industrial Estate, Leopardstown Rd, Foxrock, Dublin 18, Ireland. Phone 952316. TLX 93309.

Circle No 377

PARALLEL SYSTEM

- *Processes data at 4 to 20 MIPs*
- *Bus has a data-transfer rate of 100M bytes/sec*

The Multimax 310 modular parallel-processing system delivers 4 to 20 MIPS. You can configure the system, using 16M to 64M bytes of shared memory, a streaming cartridge-tape drive, and from 300M bytes to 4.8G bytes of disk capacity. According to the manufacturer, its Unix-based UMax 4.2 and UMax V operating systems allow the 310 to take full advantage of the power of parallel processing. An entry-level



BASU

Model CPU20 with Dual-Ported, One kbyte, SRAM Mail Box for Multiprocessor Applications

NEW 68020/SCSI Combo

Standard Features
32 Bit-Wide Address & Data Range.
Clock Rates = 12.5 & 16.
One Mbyte (4 Mbyte) DRAM with Parity Option.
One Mbyte EPROM Space.
SCSI Interface.
Two Serial Ports
• RS 232C
One Parallel Port
• 24-Bit Counter/Timer
NOVRAM
• An SRAM that saves special or user-definable variables, even at Power Fail or Power Down.

Special Features
Four LEDs.
Four-Digit Programmable Alphanumeric Display.
Four Soft Touch Control Buttons with LEDs.
EPROM Space = One 32-Pin Socket.

Options
FPU (MC68881) & PMMU Piggy Back

Operating Systems
OS-9 (*Microware)
PDOS (*Eyring)
UNIPLUS+ (*Unisoft)

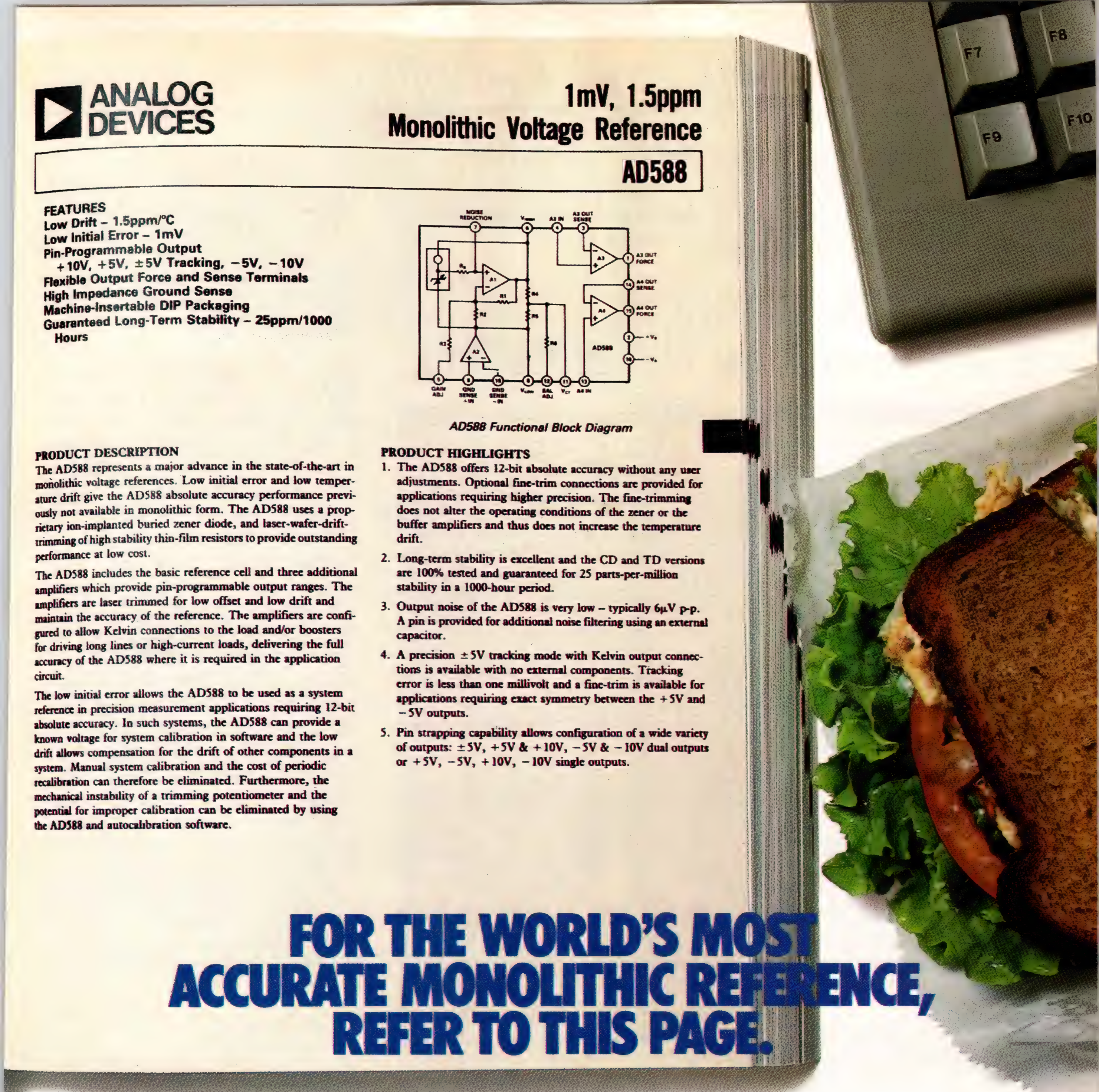
Marketed in the US by
Dage Precision Industries Inc.
PO Box 120A, Santa Clara, Ca 95052
Ph. (408) 727-1932

European Headquarters
MicroSys GmbH, Anzinger Str. 1
D-8000 Munich 80, Ph. (89)63801-0
TLX 5213288 mibad

VMEbus

Ask about our soon-to-be announced CPU21 & 22 (68020 w/Dual Ported SRAM or DRAM)

CIRCLE NO 19


NOISE REDUCTION
A3 IN
A3 OUT SENSE
A3 OUT FORCE
A4 OUT SENSE
A4 OUT FORCE
+V_S
−V_S
AD588
GAIN ADJ
GND SENSE +IN
GND SENSE −IN
BAL ADJ
A4 IN
A1
A2
A3
A4
R1
R2
R3
R4
R5
R6
F7
F8
F9
F10
FOR THE WORLD'S MOST ACCURATE MONOLITHIC REFERENCE, REFER TO THIS PAGE.

ANALOG DEVICES

1mV, 1.5ppm Monolithic Voltage Reference

AD588

FEATURES

Low Drift – 1.5ppm/°C
Low Initial Error – 1mV
Pin-Programmable Output
+10V, +5V, ±5V Tracking, −5V, −10V
Flexible Output Force and Sense Terminals
High Impedance Ground Sense
Machine-Insertable DIP Packaging
Guaranteed Long-Term Stability – 25ppm/1000 Hours

AD588 Functional Block Diagram

PRODUCT DESCRIPTION

The AD588 represents a major advance in the state-of-the-art in monolithic voltage references. Low initial error and low temperature drift give the AD588 absolute accuracy performance previously not available in monolithic form. The AD588 uses a proprietary ion-implanted buried zener diode, and laser-wafer-drift-trimming of high stability thin-film resistors to provide outstanding performance at low cost.

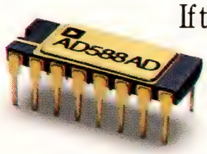
The AD588 includes the basic reference cell and three additional amplifiers which provide pin-programmable output ranges. The amplifiers are laser trimmed for low offset and low drift and maintain the accuracy of the reference. The amplifiers are configured to allow Kelvin connections to the load and/or boosters for driving long lines or high-current loads, delivering the full accuracy of the AD588 where it is required in the application circuit.

The low initial error allows the AD588 to be used as a system reference in precision measurement applications requiring 12-bit absolute accuracy. In such systems, the AD588 can provide a known voltage for system calibration in software and the low drift allows compensation for the drift of other components in a system. Manual system calibration and the cost of periodic recalibration can therefore be eliminated. Furthermore, the mechanical instability of a trimming potentiometer and the potential for improper calibration can be eliminated by using the AD588 and autocalibration software.

PRODUCT HIGHLIGHTS

1. The AD588 offers 12-bit absolute accuracy without any user adjustments. Optional fine-trim connections are provided for applications requiring higher precision. The fine-trimming does not alter the operating conditions of the zener or the buffer amplifiers and thus does not increase the temperature drift.
2. Long-term stability is excellent and the CD and TD versions are 100% tested and guaranteed for 25 parts-per-million stability in a 1000-hour period.
3. Output noise of the AD588 is very low – typically 6μV p-p. A pin is provided for additional noise filtering using an external capacitor.
4. A precision ±5V tracking mode with Kelvin output connections is available with no external components. Tracking error is less than one millivolt and a fine-trim is available for applications requiring exact symmetry between the +5V and −5V outputs.
5. Pin strapping capability allows configuration of a wide variety of outputs: ±5V, +5V & +10V, −5V & −10V dual outputs or +5V, −5V, +10V, −10V single outputs.

FOR THE WORLD'S MOST ACCURATE MONOLITHIC REFERENCE, REFER TO THIS PAGE.



If the voltage references you've been using have forced you to choose between low initial error and low drift, we'd like to refer you to our new AD588. With only 1mV of initial offset and 1.5ppm/°C of drift over temperature, it offers the best absolute accuracy possible in a monolithic reference.

This exclusive combination provides a range of user-programmable voltage outputs. You can choose from single +10V, +5V, −10V, and −5V ranges, simultaneous outputs of +10V and +5V, or −10V and −5V, or even a ±5V tracking range.

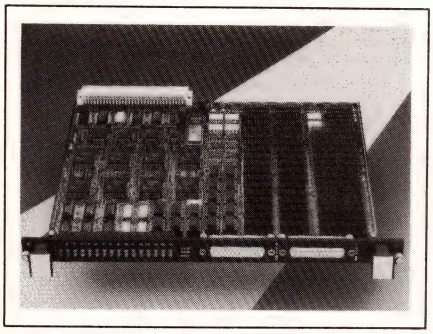
All of this is available with typical long-term stability of 15ppm, with selected versions tested for 1,000 hours and certified to be less than 25ppm. And you can get the AD588 for about half the cost of similar hybrid or in-house designs.

For the most accurate reference on the AD588, contact the Analog Devices office nearest you.

ANALOG DEVICES

Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106; Headquarters: (617) 329-4700; California: (714) 641-9391, (619) 268-4621, (408) 559-2037; Colorado: (303) 590-9952; Maryland: (301) 992-1994; Ohio: (614) 764-8795; Pennsylvania: (215) 643-7790; Texas: (214) 231-5094; Washington: (206) 251-9550; Austria: (222) 885504; Belgium: (3) 237 1672; Denmark: (2) 845800; France: (1) 4687-34-11; Holland: (1620) 81500; Israel: (052) 28995; Italy: (2) 6883831, (2) 6883832, (2) 6883833; Japan: (3) 263-6826; Sweden: (8) 282740; Switzerland: (22) 31 57 60; United Kingdom: (932) 232222; West Germany: (89) 570050

CIRCLE NO 219



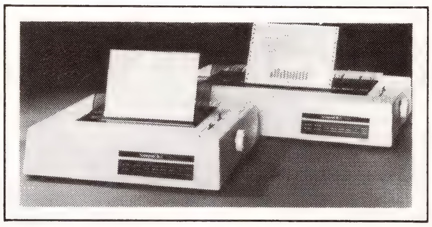
SERIAL I/O BOARD

- *Provides 16 serial I/O ports for VME Bus systems*
- *Has drivers for the OS-9/68000 operating system*

The VME-68500-SI double-Eurocard VME Bus board provides 16 independent serial I/O ports that conform to either the RS-232C, RS-423, and V.24 specifications or to the RS-422, RS-485, and V.11 specifications. Employing the RS-485 capability, you can use the board to configure low-cost LANs over more than 1000m of cable. Each port connects to a 25- or 15-pin D connector via a ribbon cable. The leadout via these ribbon-cable connections matches the DTE (data-terminal equipment) or DCE (data-communication equipment) pinouts of the relevant EIA and ISO standards. You can mount 25-pin D connectors via the board's front panel. Front-panel LEDs indicate TX-data and RX-data activity, as well as the "busy" status of each serial port. Software drivers for use under the OS-9/68000 operating system are available. DM 2480.

EKF Elektronik GmbH, Weidekampstrasse 1A, 4700 Hamm 1, West Germany. Phone (02381) 12630. TLX 828621.

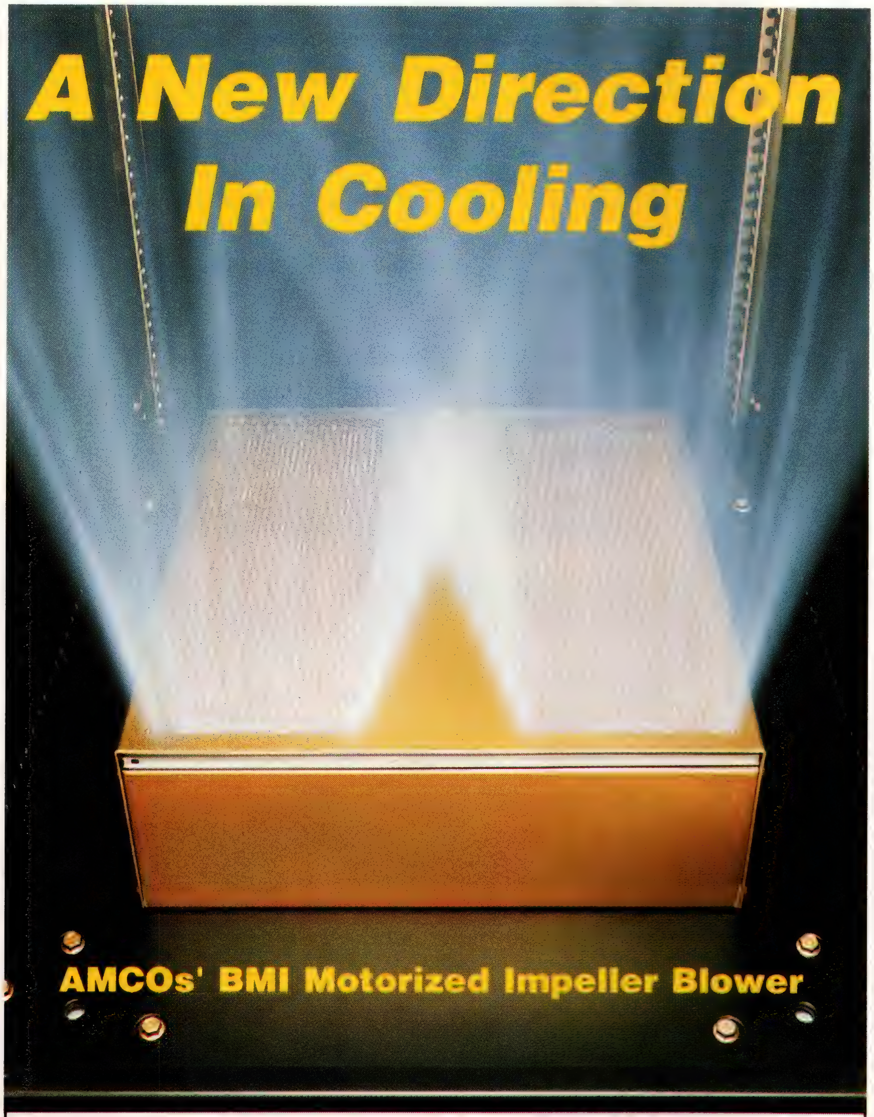
Circle No 375



PRINTERS

- *Print 200 cps in draft-quality dot-matrix mode*
- *Perform line, block, and dot-character graphics*

The Models 4/20 and 4/21 dot-matrix printers provide draft-quality printing at 200 cps. The Model 4/20 is an 80-column printer, and the Model 4/21 is a 136-column printer. They accomplish letter-quality printing at 40 cps and perform line, block, and dot-character graphics. Variable character sizes and double-width horizontal spacing are standard features, along with variable line spacing under DIP-switch control. The dot-graphics resolution is 240 dots/in. horizontally and 72 dots/in. vertically. Twenty fonts are resident on


A New Direction In Cooling
AMCOs' BMI Motorized Impeller Blower

The cost is less than a centrifugal blower with comparable air flow.

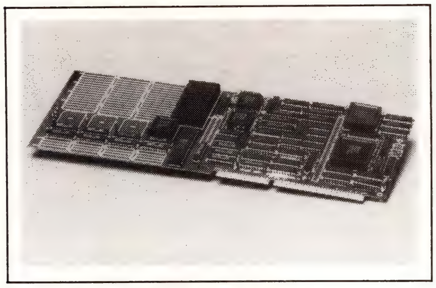
Plus these additional features:
- Static pressure up to 1.6" of H_20.
- Operating range from -30°C to +70°C.
- Can be mounted in virtually any plane.
- More air flow — SCFM Variable 445 to 540.
- Quieter operation.
- Longer life.
- Less cabinet space required.

AMCO Engineering Co.
3801 North Rose Street
Schiller Park, IL 60176-2190
TWX: 910-227-3152
FAX: 312-671-9469

AMCO®

Call Toll Free1-800-833-3156 for further information and your free full line Cooling Devices Catalog #803. In Illinois Call 312/671-6670.

CIRCLE NO 18



GRAPHICS BOARD

- *Based on National's Advanced Graphics Chip Set*
- *Reaches 1600×1280-pixel resolution, using IBM PC/AT*

Based on National's Advanced Graphics Chip Set, the Ultra 2000BW graphics board for the IBM PC/AT achieves a standard viewable resolution of 1600×1280 pixels, expandable to 2048×1536 pixels. It also handles addressable resolutions of 2048×2048 pixels/plane. The board can support as many as three additional memory planes that are stored off screen. According to the vendor, it has a 160M pixel/sec fill rate, an 80M pixel/sec bit/blt (bit-block transfer) rate, and a 10M-pixel/sec draw rate in any direction with solid or patterned lines, as well as 128k bytes of EPROM and 2M bytes of program memory. Standard unit with 1600×1280-pixel resolution, $1595.

Informations Now Inc, 6915 Hightech Dr, Midvale, Utah 84047. Phone (801) 561-1100. TLX 4992230.

Circle No 373

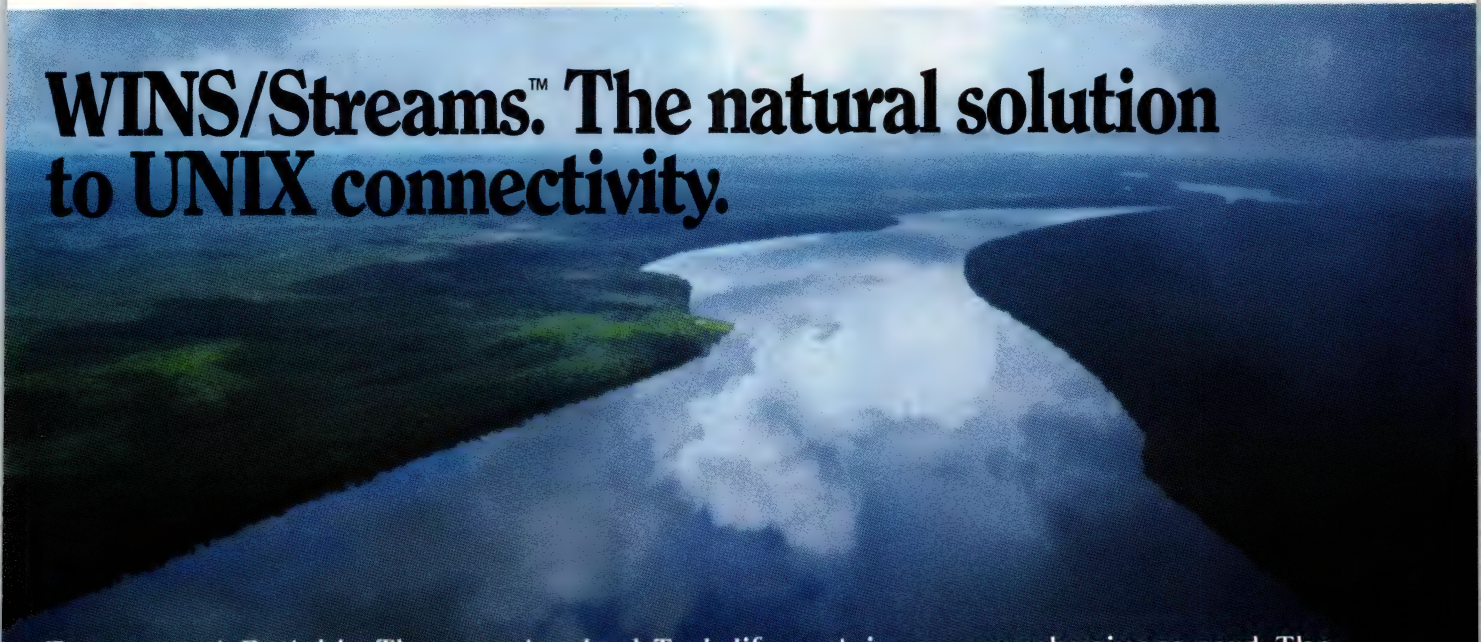
MODEM

- *Complies with CCITT V.33 and V.29 standards*
- *Uses trellis-coded modulation and features error correction*

The 2362 leased-line modem complies with the CCITT V.33 and V.29 standards. It operates at speeds from 4800 to 14.4k bps. When the modem is in V.33 operating mode, the data rates are 14.4k bps and 12k bps. At these speeds, the modem uses error-correction coding and an 8-state trellis-coded modulation to provide 99.99% error-free transmission. When the modem operates in V.29 mode, the data rates are 9600, 7200, and 4800 bps. The unit employs quadrature amplitude modulation and V.29 speeds. You can obtain an optional 4- or 6-channel time division multiplexer (TDM), all of whose channels feature asynchronous to synchronous conversion. You can obtain the modem as a stand-alone unit or in a card version, and you can also order an enclosure that accommodates as many as 16 modem cards. Stand-alone unit, $3195; card version, $2915; 4-channel TDM unit, $3795; 6-channel TDM unit, $3995.

Codex Corp, Maresfield Farm, 7 Blue Hill River Rd, Canton, MA 02021. Phone (617) 364-2000.

Circle No 374



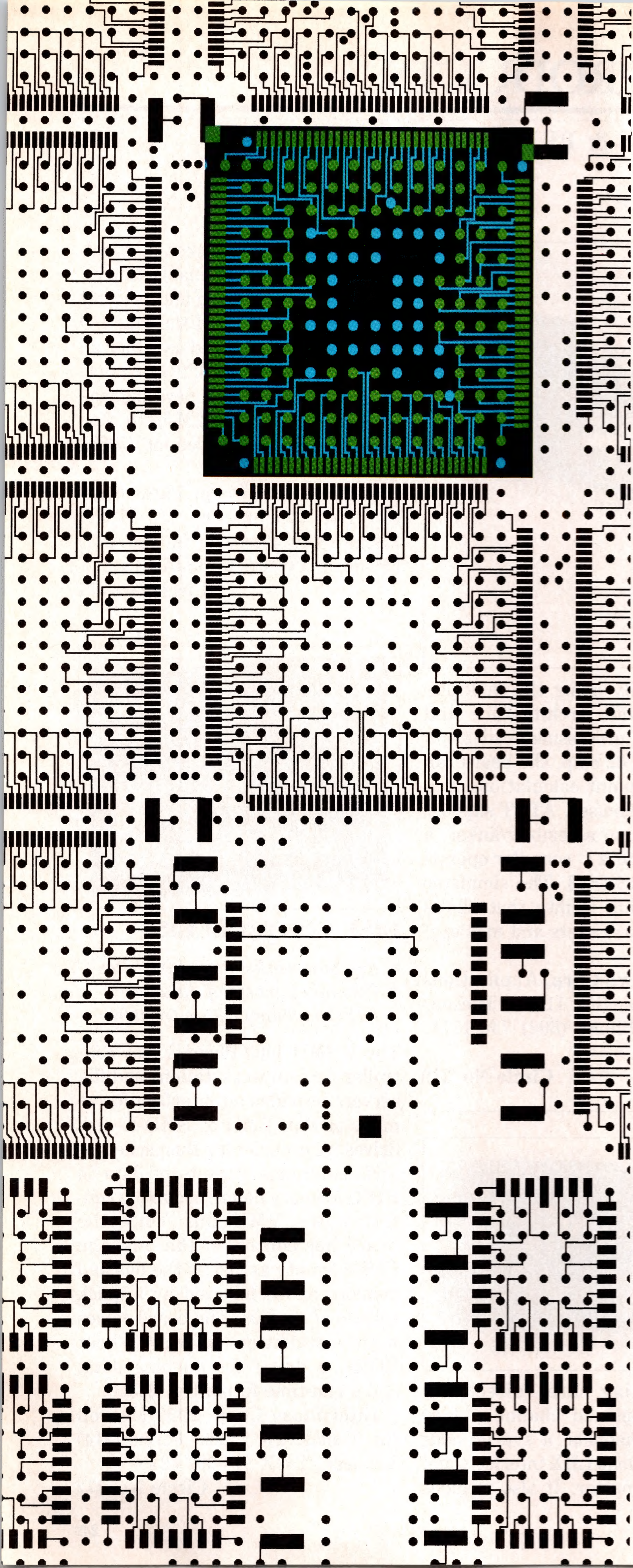
WINS/Streams.™ The natural solution to UNIX connectivity.

Transparent. Portable. The natural evolution of TCP/IP for UNIX.™ Such a natural, in fact, WINS/Streams is *the* UNIX V.3 communications standard. Truly life-sustaining. For more information, call 800-872-8649 (in California 800-962-8649) or send us this ad with your business card. The Wollongong Group, Inc., 1129 San Antonio Road, Palo Alto, Ca. 94303.

WOLLONGONG
We are the standard.℠

© 1987, The Wollongong Group, Inc. WINS/Streams is a trademark of The Wollongong Group, Inc.
All other product names are registered trademarks of their respective manufacturers.

CIRCLE NO 17



WE'VE TAUGHT THE SCICARDS SYSTEM EVERYTHING YOU NEED TO KNOW ABOUT SMT

We did it with Version 23 of the SCICARDS System, and it introduces the concept of Surface Intelligent Shapes. SIS™—an SMT intensive enhancement tailored to the needs of our customers. Version 23 contains an SIS Library that allows customized SMT footprint definitions including placement, routing and assembly information. The footprints can be built from top to bottom for standard designs or from the bottom up for hybrids. Devices can be placed on both sides of the substrate, and they can be inverted for front to back usage, *with only one definition of the shape required.* And it's very easy to use; all the commands are entered through the menu. The result is fast, effortless Surface Mount designs. We've taught the SCICARDS System everything you need to know to get your products to market first. We'd like to show you how it's done. Call 1-800-4-HARRIS for a demonstration.

7796 Victor Mendon Road
P.O. Box H
Fishers, NY 14453
1-800-4 HARRIS Ext. 4324
1-800-344-2444 (Canada)

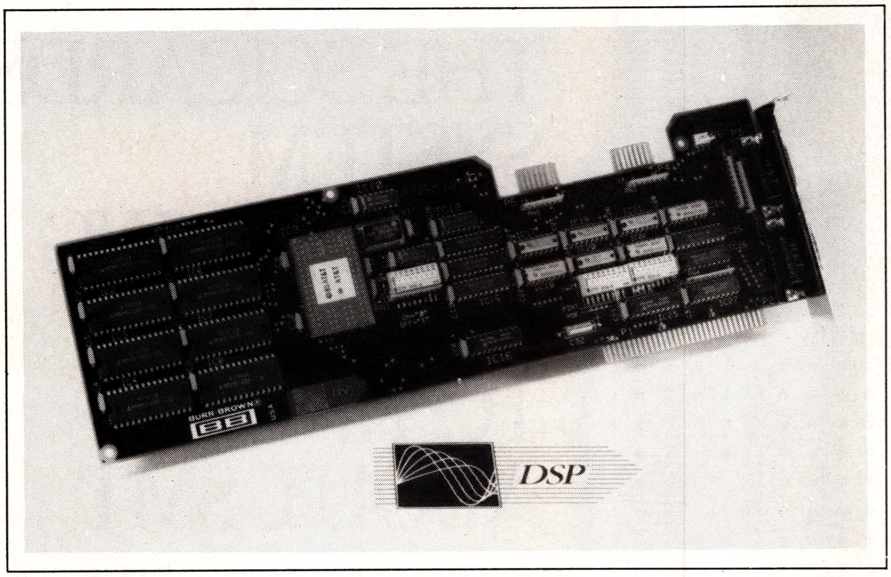
HARRIS
SCIENTIFIC CALCULATIONS

SCICARDS and SIS are trademarks of
Scientific Calculations, Inc.

CIRCLE NO 220

NEW PRODUCTS

COMPUTERS & PERIPHERALS



DSP BOARD

- *Based on AT&T's DSP32 digital signal processor*
- *Software includes a C compiler operating under MS-DOS*

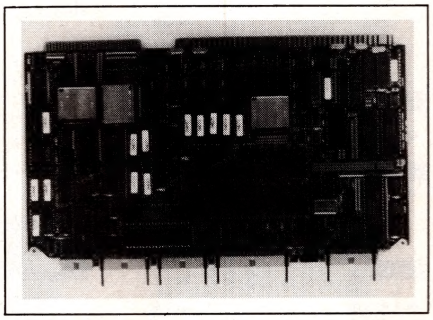
The DSPeed digital signal-processing board for the IBM PC contains an AT&T WE DSP32 floating-point processor, 64k bytes of RAM, and buffered serial I/O ports. It can implement FIR (finite impulse response) filters at a rate of 250 nsec/tap and perform a 1024-point complex FFT in 20 msec. The board transfers data across the parallel IBM PC bus or over a high-speed serial bus. By using the multiple-arithmetic-unit architecture and pipeline data processing available in the WE DSP32 chip, the board can do floating-point calculations at a rate of 8 million/sec. AT&T support tools include an assembler/linker, a simulator, and a C compiler operating under MS-DOS. The simulator is a debugging facility that allows access to all registers and memory. $995.

Burr-Brown Corp, Applications Engineering, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TLX 666491.

Circle No 370

1-BOARD COMPUTER

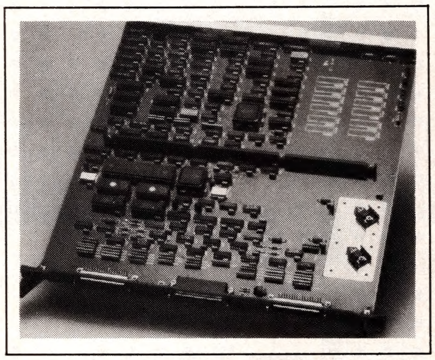
- *Uses an 8-MHz 80286 with memory management for Multibus*
- *100% software compatible with Intel's SBC 286/12*



The CD21/8286 single-board computer with 2M or 4M bytes of zero-wait-state, dual-port RAM is designed for an 8-MHz 80286 µP. The Multibus board provides memory management and is 100% software compatible with Intel's SBC 296/12. It includes interfaces for an 80287 coprocessor, an 82258 DMA controller supporting three direct and eight multiplexed channels, four serial I/O channels, a synchronous or asynchronous LBX interface, and an SBX connector. It also includes two 28-pin EPROM sockets, a parallel I/O port, programmable timers, and Multibus interface and priority interrupt logic. One of the four I/O ports can be configured as either an RS-232C or an RS-422/449 port. RMX86 and RMX286 operating systems are available. 2M-byte version, $2035; 4M-byte version, $2980 (100).

Central Data Corp, 16023 Newton Dr, Champaign, IL 61821. Phone (800) 482-0315; in IL, (217) 359-8010. TWX 910-245-0787.

Circle No 371



DISK CONTROLLER

- *For Sun workstation interfaces*
- *Formats packets of data in FIFO memory before transfer*

The V/SMD 4400 Phoenix disk controller for Sun workstations and file servers provides an interface for as many as four SMD or SMD-E disk drives. A proprietary Buspacket interface formats packets of data in FIFO memory before acquiring control of the VME Bus. Once the board has control of the bus, the FIFOs empty as fast as the bus and memory allow, followed by a quick release of the bus. The board comes with installation software, boot ROMs, a driver for queuing data, and a run-time formatter. $3350.

Interphase Corp, 2925 Merrell Rd, Dallas, TX 75229. Phone (214) 350-9000. TWX 910-997-6245.

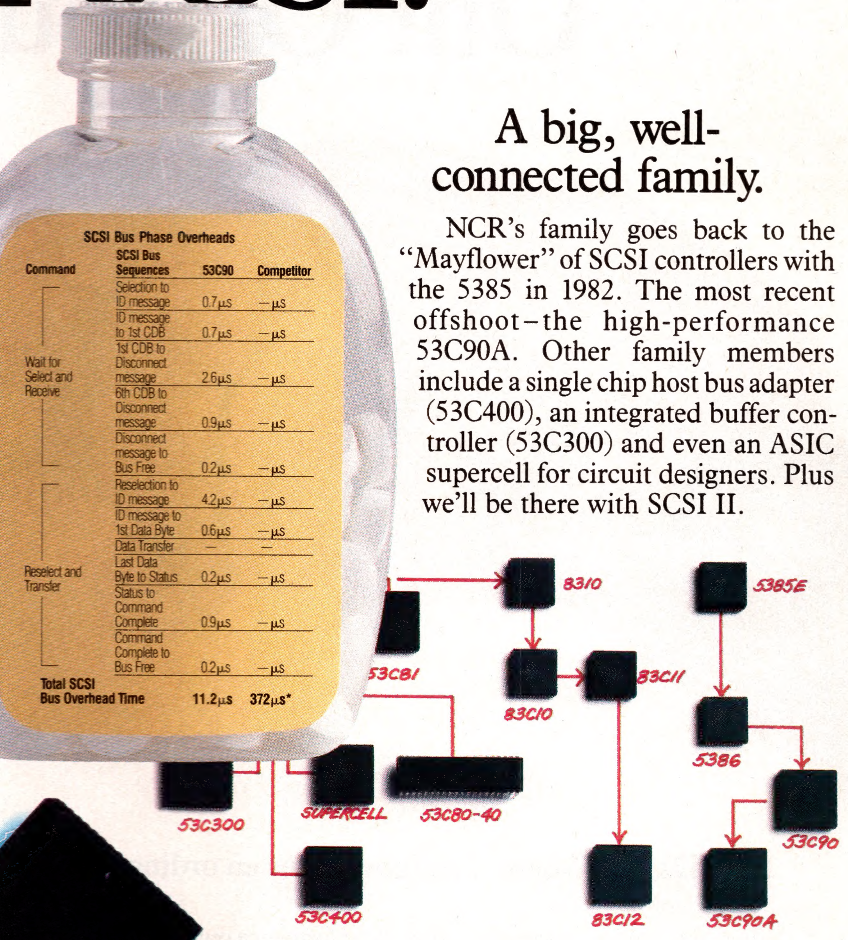
Circle No 372

NCR keeps raising the standards for SCSI.

Finally, a cure for SCSI overheadaches.

NCR's 53C90 is the only chip that can give you fast, fast, fast relief from overheadaches. Using combination commands, dedicated sequential logic and dual-ranked registers for command pipelining, the 53C90 is quickest on and off the bus. Plus NCR implements complex bus sequencing in hardware, not time-wasting software.

Transfer rates? NCR's 53C90 delivers the SCSI bus maximum of 5.0 MBytes/sec synchronous and 3MBytes asynchronous at 25MHz for the full length of the bus.



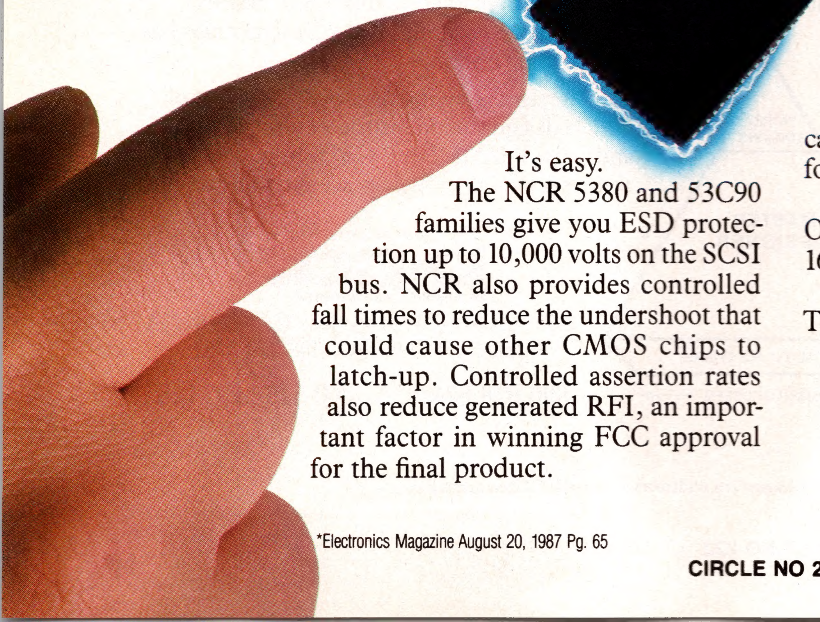
SCSI Bus Phase Overheads

Command	SCSI Bus Sequences	53C90	Competitor
Wait for Select and Receive	Selection to ID message	0.7µs	—µs
	ID message to 1st CDB	0.7µs	—µs
	1st CDB to Disconnect message	2.6µs	—µs
	6th CDB to Disconnect message	0.9µs	—µs
	Disconnect message to Bus Free	0.2µs	—µs
Reselect and Transfer	Reselection to ID message	4.2µs	—µs
	ID message to 1st Data Byte	0.6µs	—µs
	Data Transfer	—	—
	Last Data Byte to Status	0.2µs	—µs
	Status to Command Complete	0.9µs	—µs
	Command Complete to Bus Free	0.2µs	—µs
Total SCSI Bus Overhead Time		**11.2µs**	**372µs***

A big, well-connected family.

NCR's family goes back to the "Mayflower" of SCSI controllers with the 5385 in 1982. The most recent offshoot–the high-performance 53C90A. Other family members include a single chip host bus adapter (53C400), an integrated buffer controller (53C300) and even an ASIC supercell for circuit designers. Plus we'll be there with SCSI II.

How to get zap-resistance, latch-up protection and the blessings of the FCC.



It's easy.

The NCR 5380 and 53C90 families give you ESD protection up to 10,000 volts on the SCSI bus. NCR also provides controlled fall times to reduce the undershoot that could cause other CMOS chips to latch-up. Controlled assertion rates also reduce generated RFI, an important factor in winning FCC approval for the final product.

Raise your standards.

Because our chips have an edge in technology, they can help give you an edge in the market. So don't settle for the standard, call NCR today.

For documentation call our hot line 1-800-334-5454. Or write to, NCR Microelectronics, SCSI Products, 1635 Aeroplaza Drive, Colorado Springs, CO 80916.

For technical assistance, call 1-800-525-2252, Telex 452457.

NCR

NCR Microelectronics Division

*Electronics Magazine August 20, 1987 Pg. 65

CIRCLE NO 221

How To Wring Workstation-Level PCB Designs Out Of Your PC.

P-CAD's new Master Designer turns an ordinary PC into a full-fledged PCB workstation.

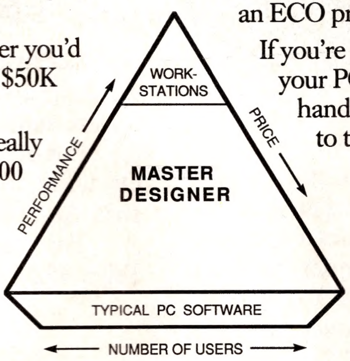
When you need to wring every drop of performance out of your next PCB design, you need Master Designer™ software.

Master Designer provides all the horsepower you'd expect only from workstations priced from $50K up to as much as $200K.

With Master Designer you can tackle the really big jobs. Board designs with 500 EICs, 32,000 pins and 2,500 nets are just the beginning.

P-CAD's Master Designer routes multiple layers simultaneously cutting the number of vias and unrouted subnets in half.

So, you'll wring out cleaner designs and higher completion rates (up to 100%).



For forward annotation of logic changes and "history independent" back annotation, Master Designer also has an ECO processing option.

If you're interested in wringing every penny out of your PCB design station instead of wringing your hands, ring P-CAD. Let P-CAD show you how to turn a PC into a high-powered workstation.

p-cad®
PERSONAL CAD SYSTEMS INC.
1290 Parkmoor Ave., San Jose, CA 95126 USA
Telex: 371-7199 FAX: 408-279-3752

800-628-8748 CA 800-523-5207 U.S.

P-CAD is a registered trademark and Master Designer is a trademark of Personal CAD Systems, Inc.

CIRCLE NO 222